THE ENGINEER

A Seven-Day Journal

Association of Consulting Engineers

THE annual dinner of the Association of Consulting Engineers was held on Wednesday, May 23rd, at the Waldorf Hotel, the principal speaker being the Lord Privy Seal, Mr. R. R. Stokes, who proposed the toast of "The Association." In the course of his speech Mr. Stokes referred to his experiences at the Ministry of Works and to his recent visit to America. He had received much friendliness and co-operation in the United States, he said, and the British point of view, which he had explained, had been well received. As he saw it, the question of raw materials supplies was a long-term one; raw materials, he said, should be made available for the whole of mankind, in an effort to improve the standard of living. He stressed the importance of the contribution of the civil engineer in this respect. Mr. R. W. Mountain, Chairman of the Association, responded and spoke of the achievements of the Association during the past year. There had been an increase in membership, he said, and ninety nominations for work in this country had been made. The joint conditions of contract for civil engineering work had been completed, in co-operation with the Institution of Civil Engineers, and the Federation of Civil Engineering Contractors, as had joint conditions of contract for mechanical and electrical work, in co-operation with the respective institutions. A new professional rule was being considered with the Institution of Civil Engineers, he continued, which stipulated that a consulting engineer practising in one of the Commonwealth countries would be entitled to adopt the rules of a responsible engineering institution in that country. The toast of "The Guests" was proposed by Sir Peirson Frank, who remarked that the present restrictions of capital expenditure had had a very bad effect on the number of qualified engineers with practical training, the opportunities in this country for such training being very limited. The toast was acknowledged by Sir Edwin Herbert.

British Transport Problems

SPEAKING at the mayoral luncheon in Swansea last week, Lord Hurcomb, Chairman of the British Transport Commission, referred to the importance of good transport and freight-handling facilities in South Wales, and dealt with some of the problems affecting transport generally to-day. It was often alleged, he said, that the staff of British Railways had grown exorbitantly since nationalisation, whereas, in fact, it had been reduced. After making allowance for unfilled vacancies, there had been a real economy in the establishment of over 40,000 employees. Nevertheless, it was incumbent upon the Commission to make every possible economy in staff in directions where that could be done, and in that respect the co-operation of the trade unions was very important. Lord Hurcomb went on to speak of transport finances, pointing out that the main explanation of the Commission's accumulated deficiencies was the interval of time between the date at which nationalised transport had had to suffer increased costs and the date at which, through one piece of machinery and another, it had been able to secure the necessary upward adjustments of its charges. If a basic industry like transport was to pay its way and discharge its duty of providing an adequate and economic national system, Lord Hurcomb asserted, its finances must be set and kept upon firm ground, and it should not be left month after month to provide service below cost. Also, transport must not be starved of the materials essential to bring its equipment into a full state of efficiency, though, Lord Hurcomb added, one could see everywhere that it had been kept on a very severe ration. Finally, Lord Hurcomb mentioned the many important docks which the Commission owned all round the coast of Great Britain. He felt that their efficiency had been improved, but the Commission would be glad if the national investment programme permitted more to be done in restoring old damage and in improving equipment.

Report on Radio Research

THE Radio Research Board of the Department of Scientific and Industrial Research last week issued its report for the year 1949. The report records the resignation of Dr. L. G. H. Huxley from the Board on being appointed to the Chair of Physics at the University of Adelaide, and welcomes the appointment of Sir Edward Appleton to fill the vacancy. During the period covered by the report radio wave propagation remained the principal subject of investigation of the Radio Research Station, Slough. The programme of work included the study of wave propagation throughout the whole radio spectrum, including ground waves and waves in the troposphere and the ionosphere. Radio noise of various kinds was the subject of a special investigation. Further studies were made of the effect of meteorological conditions on radio waves at metric and centimetric wavelengths. In the first place work was done on three different propagation paths, using transmissions provided by the B.B.C., on wavelengths of 3·33m and 6·67m. In the second place an investigation was made of some of the adverse effects of meteorological factors on radar equipment for marine navigation. From this work it is apparent, as the report shows, that the range of centimetric radar instruments can, in certain circumstances, be appreciably reduced by weather condition. Other researches in progress during the period under review dealt with the forecasting of ionospheric conditions and established the feasibility of forecasting these conditions several months ahead, many of the factors involved being of a recurrent kind. An experimental daily storm warning system was operated for a year to forecast daily variations of communication conditions, and reports of the conditions actually experienced were provided by Cable and Wireless, Ltd. The work done on special materials included studies of the properties of dielectric, magnetic and semi-conducting materials for use in crystal diodes, with particular reference to the analysis and purification of germanium. The report can be obtained from H.M. Stationery Office, price 1s. 11d. post free.

Incorporated Plant Engineers' Conference

THE annual conference of the Institution of Incorporated Plant Engineers was held at Buxton last week, under the presidency of Mr. D. Lacy-Hulbert. Mr. Lacy-Hulbert's Presidential Address, which was delivered on Wednesday, May 23rd, was entitled "To-day." In the course of it he said that with a given set of conditions of mechanical aids—that is plant and machinery in factory or on building site—there was theoretically a limit to the height of labour efficiency which could be achieved, though in practice no management would confess to have reached it. The production manager, Mr. Lacy-Hulbert observed, was happily not alone in his task, for the plant engineer had a complementary and equally important part to play. Mr. Lacy-Hulbert went on to suggest that the plant engineer's primary yardstick for productivity was output per machine-hour. Old and worn-out plant was continually being called upon to stand up to more rigorous conditions, and the mortality rate of such plant threatened to rise while its expectation of life was falling. That made the task of maintenance ever more difficult and exacting for the plant engineer, for it was his everyday duty to keep his machines on the line. It must also be remembered that, as the output per machine-hour rose, so relatively did breakdowns have a more serious meaning, and they must be anticipated and prevented. That, Mr. Lacy-Hulbert pointed out, was a heavy responsibility, which was undertaken by the plant engineer, but it was one which was not without its compensations. For the plant engineer learned those subtle and important points which could be understood only by the man of practical experience, and eventually came to know his machines as a doctor knew his patients. Increased productivity meant for the plant engineer, in particular, first-class maintenance and a continued advancement in the efficiency of all new plant. It involved, too, Mr. Lacy-Hulbert suggested, the development of a wider appreciation of the financial and economic aspect of production.

The Federation of Coated Macadam Industries

THE Federation of Coated Macadam Industries held its annual luncheon at the Dorchester Hotel on Friday, May 25th. Some 500 members and guests were present, and the toast of "The Federation" was proposed by the Secretary of State for Air, Mr. Arthur Henderson. Mr. Henderson spoke of the importance of the Federation's contribution to airfield construction, and of the successes achieved by its members during the last war. He thought that a solution would be obtained shortly to the problem of damage of bituminous surfaces by jet exhausts. Mr. Cecil Martin, Chairman of the Federation, responded. He noted that the tonnage of coated macadam manufactured or laid by members during 1950 was 5,800,000 tons, some 10 per cent in excess of the previous year and a record for the Federation. He appealed for increased grants to make good the severe and unprecedented damage to the roads caused by the weather conditions last winter. Mr. John Hadfield, vice-chairman, proposed the toast of "The Guests." He thought that during the next ten or fifteen years the number of mechanically propelled vehicles might increase to the level now ruling in the United States—one to three or four of the population, as against one to thirteen or fourteen in this country—and the capacity of the roads would also have to be developed. He was supported in this view by Dr. W. H. Glanville, President of the Institution of Civil Engineers, who replied to the toast. During the course of his speech Dr. Glanville noted that many of the problems of quality control of bituminous construction required full-scale tests for their solution, which was very difficult to arrange at present. He said that road transport accounted for some 10 per cent of the national income, and probably 50 per cent of the effort of the civil engineering industry was devoted to roads and airfields. The annual general meeting of the Federation was held immediately after the luncheon.

The South Bank Exhibition

No. V—(*Continued from page 674, May 25th*)

Agricultural Tractors

THE four tractors to be seen in the Country Pavilion at the South Bank Exhibition are a representative selection from those which are now being produced by a number of British firms. It is noteworthy that last year there were over 117,000 agricultural tractors (excluding small market garden machines) built in this country, many of them for home use, but quite a big proportion to meet export requirements. The development of the tractor has had a tremendous influence on agricultural practice in this and most other countries of the world. The tractor is now much more than a haulage machine for certain implements. By its power take-off, it can turn the working parts of such equipment as harvesters and manure spreaders; stationary machinery can be driven by means of the belt pulley, while the hydraulic power lift of a tractor is used to raise, lower and regulate the depth of mounted implements. Consequently, there is now a big selection of implements specially designed and adapted for work with particular makes of tractor.

The tractors exhibited are illustrated by photographs reproduced in Plate 2. They are the "Fordson Major," made by the Ford Motor Company, Ltd., Dagenham, Essex; the Ferguson tractor, which is built by Harry Ferguson, Ltd., Coventry; the Nuffield "Universal," which is a product of Morris Motors, Ltd., Cowley, Oxford, and the "Trackmaster," which comes from David Brown (Tractors), Ltd., Meltham, Huddersfield. As will be noted from our illustrations, the three first-mentioned are wheeled tractors, and the fourth is equipped with tracks. The Fordson "Major" is the firm's "land utility" model, which is provided with pneumatic tyres. It is fitted with a four-cylinder, four-stroke engine, having a detachable cylinder head and side-by-side valves, which working on vaporising oil, is capable of producing 30·5 h.p. at 1200 r.p.m. The final drive from the gearbox is by crown wheel and pinion to the cross shaft, embodying differential, and from the cross shaft to the axle shafts by spur gearing. The braking system consists of a hand-operated multiplate transmission brake, and independent brakes mounted on the cross shaft and operated by two foot pedals. Provision is made for three forward speeds and one reverse, and the tractor weighs 4214 lb.

The Ferguson tractor shown is another pneumatic-tyred machine, with a four-cylinder petrol engine giving about 24 h.p. It is provided with self-starter and battery, coil ignition, and a constant-mesh gearbox arranged for four forward and one reverse speeds. At 2000 r.p.m. the forward speeds range from 3⅜ m.p.h. to 13¼ m.p.h. the second speed 4⅛ m.p.h., being recognised as the normal ploughing speed. Another arrangement of the Ferguson is with a four-cylinder, overhead valve, vaporising oil engine developing maximum torque between 1000 and 1500 r.p.m.

The power unit of the Nuffield "Universal" tractor is based on the Morris-Commercial "ETA" side-valve engine. Its four cylinders, 100mm bore by 120mm stroke, are fitted with austenitic dry liners, and it has an output of 33 h.p. at 1400 r.p.m., and 38 h.p. at 2000 r.p.m. The engine governor is driven by timing chain at crankshaft speed and is designed for maximum sensitivity over a speed range of 600 to 2000 r.p.m., its power at small throttle openings being accentuated by means of toggle linkage connection to the carburettor. The final drive is taken by high-speed differential of 4·38 to 1 ratio, driven by spiral bevel gears. There are five forward road speeds, ranging from 2·26 m.p.h. to 17·3 m.p.h., with the engine running at 2000 r.p.m., and a reverse speed of 3·96 m.p.h. This tractor, like the Fordson "Major" and the Ferguson, is equipped with a power take-off unit, and hydraulic lift linkage, and a belt pulley for stationary work. In addition, all these three tractors can now be supplied, if desired, fitted with a Perkins diesel engine.

The David Brown "Trackmaster" displayed in the Country Pavilion is a diesel-engined tractor. The four-cylinder engine, which is a David Brown production, has been designed to give a maximum of 35 b.h.p. It is fitted with C.A.V. injection equipment acting directly into a toroidal-shaped combustion chamber which, it is claimed, promotes the utmost turbulence of fuel-air mixture. Transmission is through a six-speed gearbox giving six forward and two reverse speeds, the forward range being from 1·06 m.p.h. in low gear to 6·45 m.p.h in top gear at engine speeds of 1600 r.p.m and 1800 r.p.m. respectively. The conventional clutch and brake steering has been replaced on the "Trackmaster" by power controlled steering on the "Duotrack" system. It is a system of epicyclic gearing used in conjunction with a spur differential so arranged that a definite turning radius is obtained. A tractor with 40in tracks, the makers say, has a turning radius of 7ft to 8ft. Alternative track widths of the "Trackmaster" are 40in, 48in, 56in and 64in. The ploughing speed of the tractor, with a four-furrow plough, is given as 3 m.p.h.

Power and Production Pavilion

The purpose of the Power and Production Pavilion is to present a picture of British manufacturing industry from the generation of power, and its use in the processing of raw materials, to the production of the finished article. To develop this theme in the limited space determined by a floor area of about 300ft by 100ft, overlooked by a gallery, demanded a strictly selective system of portrayal which may account for the impression created that some aspects of the subject have received rather cursory treatment. For example, the whole chain of processes involved in the generation of electricity in a modern steam power station—including the handling of coal and its combustion, the raising of steam and the many associated services—is modestly represented by one main exhibit which takes the form of a three-quarter scale mock-up of a 60MW turbo-alternator. However, although the exhibit itself gives little indication of the fact, the plant portrayed by the mock-up is not without technical interest. It represents a new design by the Metropolitan-Vickers Electrical Company, Ltd., for a turbo-alternator with a maximum continuous and economic rating of 60MW, the steam conditions being 900 lb per square inch gauge and 900 deg. Fah. at 28·9in vacuum on the maximum continuous rating. The turbine is a two-cylinder, close-coupled, unit with three bearings. The high-pressure and low-pressure rotors are solidly coupled, the wheels on each being solid with the shaft. There are nineteen stages in the high-pressure cylinder, while the low-pressure end is a double-flow cylinder with six stages in each flow. The turbine is arranged for four-stage feed heating, with a bled steam de-aerator feed-heating stage.

A number of turbo-alternator sets for the British Electricity Authority are now being built by Metropolitan-Vickers Electrical Company, Ltd., to the new design, which is characterised by considerable economy in overall length and, therefore, in station costs.

National Grid Control Centre

Turning from this exhibit, which represents the generation of electrical power, to another which illustrates the control of that power on a national scale, the visitor sees a mock-up of the British grid control room as it may be expected to appear in 1955, when part of the new 275kV "super grid" should be in operation.

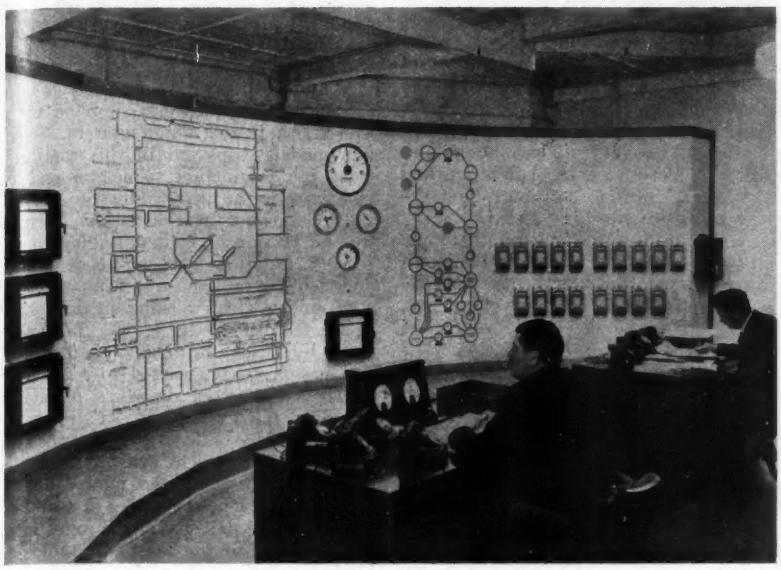
To appreciate the significance of this exhibit it is perhaps as well to consider, first, the national grid control room as it now stands and, secondly, the ten-year development programme which will bring into being the 275kV grid.

For convenience of operation the British grid system is divided into eight areas with their respective control centres at Glasgow, Newcastle, Manchester, Leeds, Birmingham, Bristol and London (North and South), each of which is responsible for the operation of the transmission lines substations and the generating stations in its own area. Overriding control of the area centres is exercised from a national control centre (at present housed in a temporary building in Paternoster Square, E.C.1) which is responsible for the general continuity of electricity supplies, for the economic transfer of energy between the areas and for the maintenance of system frequency. The first and second of these requirements gives rise to the important function of co-ordinating maintenance programmes for generating plant and main transmission lines. As long as the present shortage of generating plant capacity persists, one of the main day-to-day tasks of the national control centre is the sending out of load shedding instructions to any areas where there may be a risk of overloading the generating plant or the grid circuits due to the uneven demands made on different parts of the system.

Part of the present national control room is shown in one of the accompanying illustrations. When load shedding becomes necessary, the national control engineer, who is seated at the left-hand desk, has to decide on the timing of his load shedding instructions in such a way as to prevent the system frequency from falling below 48 c/s. To assist him in anticipating changes in frequency the control engineer makes use of the information given by a rate-of-change-of-frequency meter mounted alongside a frequency meter on his desk. The first indication of any significant change of load is given as a rate of change of frequency which gives the engineer time to act before the frequency itself can fall to the danger point.

All the information required by national control is set out on a curved panel in front of the control desk. On this panel are mounted frequency meters, clocks and time-error recorders to provide a permanent record of the main operational characteristics of the system. As shown on the left of our illustration the panel displays a diagram of the complete grid system, whereby the national control engineer can mark any lines

that may be out of service for maintenance or repair, and can determine the lines that are available for the transfer of energy. Further to the right of the panel is a simplified diagram of the inter-area lines, with a meter mounted in each line to show the amount of power transferred between areas. Part of the panel will eventually incorporate a diagram of the 275kV grid on which the condition of each circuit breaker will be indicated automatically.



NATIONAL GRID CONTROL ROOM

THE 275kV GRID

In anticipation of future requirements the British Electricity Authority decided more than a year ago that a substantial increase would be required in the capacity of transmission lines connecting various parts of the country. Earlier this year a provisional ten-year programme for a 275/300kV grid was approved by the Authority. As outlined in the accompanying sketch map, the scheme provides for new transmission lines running from Glasgow via Carlisle, Newcastle and Sheffield to Staythorpe, near Newark-on-Trent, and thence to the London area. There will be a ring formed by a line from Staythorpe linking the East Midlands, Manchester, Blackburn and Leeds. A second main trunk line to the London area will be provided by a connection between the East Midlands and West London. Another line to the South of England will link the East Midlands, Birmingham, Melksham and South-West London.

A loop, connecting Tilbury on the north bank of the Thames with Littlebrook on the south bank, will include the three main receiving centres on the north, west and south-west outskirts of the London area. The voltage of the new system will be 275/300kV, but the design of certain sections, mainly those between the Midlands and London area, is being considered with a view to the possibility that they may be required, ultimately, to operate at 380/400kV.

OUTLINE OF 275kV GRID SCHEME

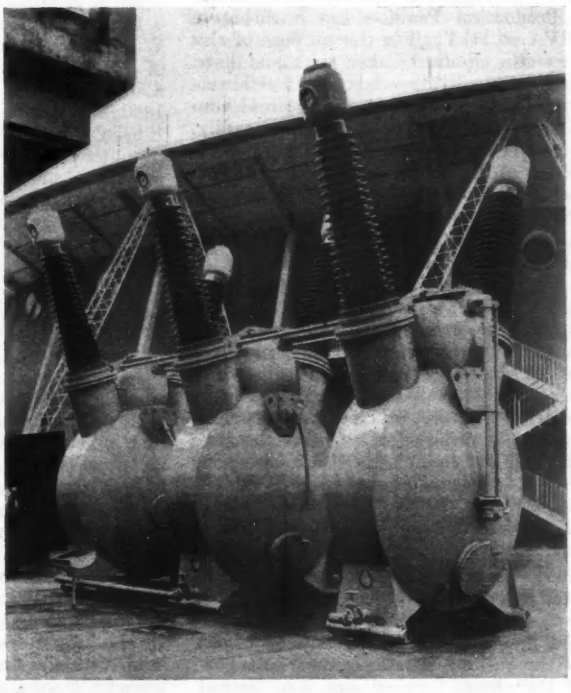
When the British Electricity Authority announced the programme early this year it was stated that, while detailed arrangements for interconnecting the new system with the existing 132kV network were being worked out, the intention was that the major part of the new lines would be completed by 1955, and that some sections would be operating at 275/300kV. It may be recalled that, in anticipation of the new project, one section of line between Staythorpe and West Melton, near Sheffield, was put in hand some time ago. Constructional work on this section is now in an advanced state. With this line as the start of the scheme the first major extension to be undertaken will probably be northwards from Sheffield, through Newcastle, and Carlisle to Glasgow, providing an urgently needed reinforcementto the supply system of the North-East Coast industrial area.

CIRCUIT BREAKERS

The decision to proceed with the construction of a 275kV transmission system means that, in addition to overhead line equipment and cables, transformers and switchgear will be required to operate at that voltage. An example of the switchgear that has been designed for this class of service is arranged as an outdoor exhibit between the Power and Production Pavilion and the Dome of Discovery. It consists of a British Thomson-Houston "Shuntarc" oil circuit breaker made up of three identical single-pole units which are coupled together by operating rods and links to form a three-pole assembly, as illustrated below. In switchgear of this size it is important, from economic considerations, to limit the amount of oil required in the circuit breaker tanks, and, by developing a lenticular tank the manufacturer was able to achieve a reduction of about 30 per cent in oil volume compared with that of the conventional cylindrical tank.

Each circuit breaker has two breaks per pole, arranged so that each moving contact operates in a "Shuntarc" self-compensated arc-control chamber shunted by a wire-wound, non-inductive switching resistor. The resistor is of nickel-chrome wire, wound without any joints and connected between the fixed contact assembly and a contact gate in the throat of the arc-control chamber. The fixed contacts are rolling butt contactor fingers, fitted with heavy backing springs to give ample contact pressure and a short overlap time.

A duralumin crossbar carrying two tubular duralumin contacts forms the moving contact assembly, the inertia of which has been kept to a minimum. A further reduction in the inertia of the moving parts is achieved by the use, wherever possible, of densified, impregnated, laminated wood. Other measures to reduce the operating time include the use of a quick-acting, low-inductance trip solenoid and of simple



275kV "SHUNTARC" OIL CIRCUIT BREAKER

linkages with ball bearings and stainless steel bearing pins to reduce friction.

A high acceleration is given to the moving parts, on opening, by torsion bar springs of high duty chrome vanadium steel. The combined effect of these considerations on the speed of rupture is to reduce the total break time to 0·06 seconds, or 3 cycles at the standard British frequency. Closure of the circuit breaker contacts is achieved by a compressed air operating mechanism mounted in a weatherproof housing on the circuit breaker tank. Access from the ground to the interior of each tank is given by a large manhole with hinged cover.

The circuit breaker bushings are of the normal B.T.H. oil-filled design, comprising a central conductor surrounded by concentric Paxolin cylinders immersed in oil and enclosed in compression porcelains. Magnetically operated oil gauges are fitted in the expansion heads of the bushings and space is allowed in the earthed barrel of each bushing for the usual ring-core current transformer.

To achieve the necessary clearances for operation at 275/300kV each circuit breaker stands 24ft high overall, the maximum width over the bushings being 15ft 6in. When the three units are arranged (as illustrated) as a three-phase installation with a spacing of 12ft 6in between centres, the overall length, in plan, is about 34ft.

The circuit breaker is designed to comply with B.S. 116 and has a rated rupturing capacity of 15,800A on symmetrical short circuit, or 19,800A on asymmetrical short circuit; the making capacity is given as 40,300A.

Another example of power station switchgear to be seen at the exhibition is the Reyrolle "C6T" equipment. It is a typical member of a range of horizontal draw-out metalclad switchgear with oil circuit breakers for power stations and substations, and, as such, is a direct descendant of a design which was introduced by A. Reyrolle and Co., Ltd., as long ago as 1906. It is made with single and duplicate busbars and is suitable for many uses, such as controlling generators, transformers, feeders and reactors, and sectioning or coupling busbars.

The particular unit shown in the Power and Production Pavilion has a rating of 250MVA at 11kV. For the purpose of this display the circuit breaker tank and hood and the cable-dividing box are fitted with Perspex windows so that the internal construction and lay-out can be seen readily. As a matter of interest, the production bench assembly of the switch-operating mechanism forms the subject of a separate exhibit which is referred to in another part of this article.

In the "C6T" switchgear the oil circuit breaker has two breaks per phase, fitted with "turbulators" for arc control. During opening each moving contact travels vertically downwards in the turbulator chamber, which is vented transversely by a series of slotted openings through which the gas and oil can escape under pressure generated by the arc, which thereby produces a strong de-ionising effect. Operation of the circuit breaker contacts is either by spring or by d.c. solenoid. In each case, the mechanism is trip free, so that the circuit breaker is free to open if tripping is initiated at any part of the closing stroke.

Interlocks and safety devices are incorporated to prevent incorrect operation, as follows. First, the circuit breaker cannot be racked in or out with the contacts closed, since the racking handle cannot be moved until the circuit breaker has been opened. Secondly, the circuit breaker can only be closed in the "fully home" position, in the "test" position, or the "fully withdrawn" position. Thirdly, the tank cannot be lowered unless the circuit breaker is fully withdrawn. Fourthly, when the circuit breaker is withdrawn the busbar and current transformer chamber orifice contacts are automatically covered by locking-off doors.

Illumination

Illumination, which was an early application of electricity and is still the most widespread, forms the subject of a sequence of exhibits which trace the development of artificial light from the candle to the fluorescent lamp. The display culminates in a selection of well-designed contemporary lighting fittings which typify current practice in direct, indirect and general lighting, and illustrate the importance of controlling the intensity and direction of lighting.

The story begins with a photographic reproduction of a portrait of Benjamin Thompson, Count Rumford, the versatile soldier, administrator and man of science, who was one of the moving spirits behind the establishment of the Royal Institution. His scientific interests included studies on the explosive effect of gunpowder, the design and making of firearms, systems for signalling at sea and the nature of heat. For the present purpose his main claim to a position in the history of illumination was his pioneer work in photometry, which provided a basis for the art of illumination by the control of luminous intensity and its direction.

The next portrait in the sequence is one of Sir Humphrey Davy, who is best known for his invention of the safety lamp, which depends on the principle that, if a piece of metal gauze is placed between a flame and an explosive gas, the heat of the flame is conducted away by the metal gauze, which thus prevents the explosive mixture from igniting. Electro-chemistry formed Davy's chief interest, but he made at least one more contribution to the progress of lighting when he demonstrated the operation of an arc lamp in 1810.

Another picture, which was loaned to the exhibition by the Gas Council, shows Murdoch using gas as an illuminant for lighting his office at Redruth.

Finally, there is a portrait of Sir Joseph Wilson Swan, whose name is linked with that of Edison as the father of the incandescent filament lamp. In fact, Swan's work in 1860 anticipated, by nearly twenty years, Edison's method of producing light by incandescence. What Swan did in 1860 was to make an electric lamp containing a carbon filament, formed by packing pieces of paper with powdered charcoal and subjecting the pack to a high temperature in a crucible. The carbonised paper that resulted was cut into a fine strip, mounted in an evacuated glass bulb, and connected to a battery of cells which provided enough current to make the filament red hot.

Later, Swan evolved an improved filament which consisted of a cotton thread treated with sulphuric acid. In 1878 he made the first practical form of electric lamp using an incandescent carbon filament. A number of such lamps were used by Swan in Newcastle in 1880, when he gave the first public exhibition of lighting on a large scale with filament lamps.

Passing on to more recent times the exhibition shows how the pioneer work has developed along two main lines, represented by the incandescent lamp and the discharge lamp with the fluorescent lamp as its latest branch. Several examples of metal filament lamps, discharge lamps and fluorescent lamps are exhibited to show the prodigious variety of modern light sources, their characteristics, and the fittings whereby the illumination can be dispersed or concentrated as required to suit any particular application.

Metals

The first sequence of interest to engineers in the production section of the pavilion is the gallery of metals where a series of wall panels shows various metals as raw materials and their processing and treatment. Metals are shown in ingot, slab, sheet, strip and wire form, together with some typical forgings and extrusions, and examples of sand, die and gravity castings supplied by many well-known British manufacturers. Some very fine models displayed in this section illustrate the production sequences and equipment used in the heavy industries.

The largest of these models has been loaned by the Davy and United Engineering Company, Ltd., of Sheffield, and is of a blooming and slabbing mill and a continuous billet and slab mill. This working model, which is illustrated in Plate 4, was fabricated in steel by Mills Brothers (Sheffield), Ltd., and has been constructed to a scale of $\frac{1}{8}$in to 1ft from actual drawings of the corresponding full-scale plant. It is over 13ft long and is driven by a $\frac{1}{4}$ h.p. motor through a mechanism which synchronises all the mechanised parts of the model. It shows the whole sequence of rolling in a mill of this kind from the delivery of the ingot from the soaking pits, to the approach table of the blooming mill, and to the transfer of the finished billets to the cooling banks.

The full-scale plant, which is at present being built for the Consett Iron Company, consists essentially of a 44in by 108in high-lift slabbing and blooming mill followed by a ten-stand Morgan continuous billet and slab mill. The billet and slab mill is divided into two sections—a six-stand group and a final four-stand group, each provided with separate cooling banks. When completed the plant will replace a slabbing mill which was built by the Davy and United Engineering Company for the Consett works in 1925, has been in continuous operation for the past twenty-six years.

The slabbing and blooming mill will roll slab ingots up to 20 tons and bloom ingots up to 10 tons, its output totalling some 22,000 tons a week. Of this output 6000 tons will be in the form of slabs from 46in by 16in to 36in by 6in up to 50in wide, and the remainder will be in 9in by 9in blooms and a small quantity of 16in by 16in blooms. In this mill 90-ton housings with post areas of 670 square inches will be used. It will have a twin drive from two 4100 h.p. electric motors of 12,300 h.p. peak each. It is being fitted with electrically operated manipulators, a twin motor screwdown with a screwing speed of 255in per minute, independent breast roller drive and hydraulic roll balance gear. The comprehensive range of auxiliary equipment to be supplied will include a side-tipping ingot car, provision for future fitting with a 66in horizontal sliding-frame hot saw and one 1340 tons electrically-operated down-and-up cut hot slab and bloom shear. The roll necks will have "Morgoil" bearings, and roller bearings are being fitted on all the roller table gear. A centralised system will control oil and grease lubrication to all points.

The Morgan continuous mill has been designed for the 9in by 9in blooms forming the major part of the blooming mill output, and will roll down to 2in square billets or 4in by 1$\frac{1}{2}$in slabs. Slabs up to 24in by 2$\frac{1}{2}$in will also be produced. In this unit the six-

stand group is composed of three 30in vertical and three 28in horizontal stands; the four-stand group has two 24in vertical and two 21in horizontal stands. Each stand will be individually driven through a gearbox by a 1250 h.p. motor and will have an electrically operated screwdown. The estimated weekly output of billets and slabs is 16,000 to 17,000 tons per week.

In the model of the blooming and slabbing mill shown on Plate 4 the manipulator gear and the rolls move and operate. The photograph of the continuous mill reproduced on the same Plate shows also the 220ft by 35ft transport bank which provides a take-off for material from the six-stand group and carries the billets down to the hot saw, which is just out of the picture on the right.

Another interesting model in this section is of a 6000 tons forging press supplied by the Davy and United Engineering Company, Ltd., which was built by its subsidiary company, Duncan Stewart and Co., Ltd., of Glasgow, for the works of William Beardmore and Co., Ltd. The actual press from which the model was made is illustrated on Plate 3; it was designed for forging ingots weighing up to 150 tons and up to 8ft 4in diameter. Included in the variety of forgings made on this machine are turbine drums up to 16ft diameter and gear rings up to 17ft 6in diameter by 5ft 9in wide. The overall height of the press, which weighs 1427 tons, is nearly 60ft and its width is about 154ft. It is of steam-hydraulic design and is driven through two steam-hydraulic intensifiers giving a stroke to the main press of 12in per stroke of each intensifier. The hydraulic working pressure is 2½ tons per square inch and the steam pressure is 150 lb per square inch. For handling the tools or forgings under the press a hydraulic manipulating gear is provided, and tables extend for a distance of 40ft on each side of the press.

In another model, the forging shop of John Garrington and Sons, Ltd., there is shown equipment made by a number of firms for induction heating, forging and trimming and, in it, the sequence of operation in a modern forge can be clearly followed.

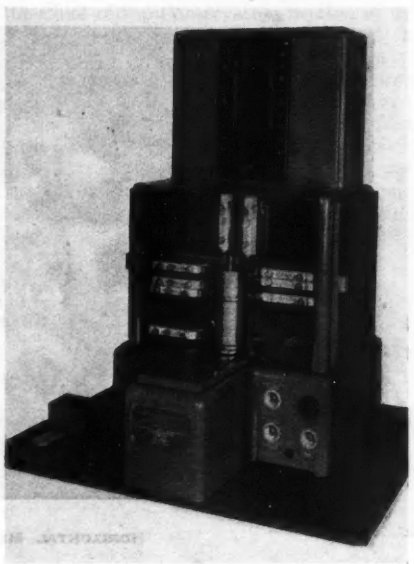
Together with the various types and sizes of wire exhibited there is shown a set of wire drawing dies with a wire drawing demonstration panel and a model of a typical wire drawing machine made by the Marshall Richards Machine Company, Ltd.

Testing Equipment

The next stage in the natural sequence dealing with metals in the gallery of this pavilion are displays dealing with metals research and the testing of products. As the subject of metals research is covered by seven exhibits only, its field is strictly limited and it gives but a slight impression of the work and equipment involved in research and testing in modern metallurgical laboratories. From the very wide range of metallurgical laboratory equipment made in this country and the many forms of metal inspection, there has been selected for purposes of exhibition a series of creep test specimens and a jet engine casting in magnesium-zirconium alloy, together with Salter hanging spring balances, Hounsfield tensile and impact testing machines, and a creep testing machine by S. Denison and Son, Ltd.

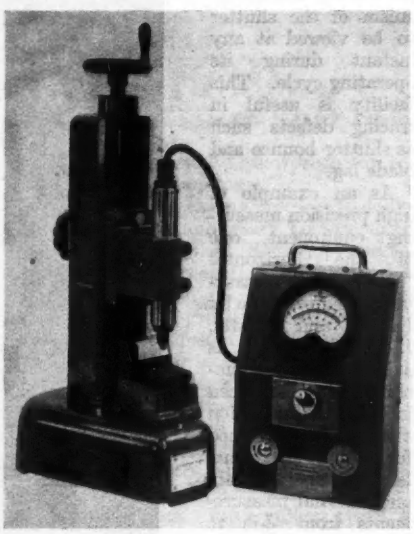
This machine has a capacity of ¾ ton and takes specimens having an effective length of 1in to 2in. Its weighing system is supported by four steel columns from the cast iron baseplate and the screw and bevel straining or setting gear can be operated from each end of the machine. Adjustable furnace rests are provided and specimen holders of creep and heat-resisting material are connected by universal joints in the steelyard and setting screw.

The weighing gear comprises a 10 to 1 steelyard or weigh-beam and loadings as low as 0·0125 ton or ½ ton per square inch can be used. Using the proportional weights supplied, any loading between ½ ton per



MULTI-DIMENSION INSPECTION MACHINE

square inch and 30 tons per square inch in ½ ton per square inch increments can be obtained. Buffer blocks on the baseplate take the load off the steelyard when the specimen fractures, and before the steelyard comes to rest, to prevent damage to the knife edges. A dial extension indicator above the steelyard is marked in increments of



COMPARATOR AND GAUGE HEAD

0·0005in, which equals 0·0001in on a specimen.

The equipment dealing with the testing of products covers a variety of industries from testing the strength of yarns to cloth-wear testing, a portable viscometer and a rubber resilience testing apparatus, optical and aero instrument testing apparatus, &c. Amongst these instruments is to be seen one of the multi-dimensional inspection machines made by the Sigma Instrument Company, Ltd., of Letchworth. This machine, which is illustrated on this page, is semi-automatic in operation and its functions are controlled by a series of switches fitted to the front of the base.

The basic units in these inspection machines are the electric signal gauges, which are made in various ranges and are designed to give results within 0·00005in. Movement of the anvils of these gauges converts the physical size of a component being inspected into an electrical impulse which is used to illuminate signal lights. Each gauge incorporates adjustable electric contact screws by which the tolerance adjustment over the range is made. The machine exhibited is adapted for the inspection of cylinder liners on nine dimensions indicated on the diagram panel over the gauging assembly. Its base incorporates a feeding slide on which the liners are carried one at a time into position in the gauging head, where suitable electric signal gauges are mounted on calliper and fixed units. A relay unit connects the gauges to the gauge diagram, where signal lights indicate the plus and minus limits of each dimension, and a single "O.K." light is illuminated if all the dimensions are inside the prescribed tolerance boundaries.

When the machine is switched on for continuous running the feed slide automatically enters and returns from the gauging position with a definite pause for loading and gauging at each cycle. Individual gauging and loading movements can be controlled by means of a pedal if continuous running is not required. The makers point out that under normal conditions some 600 liners an hour can be gauged in this machine, and, since the check is made at nine points, no less than 5400 dimensions can be measured in an hour.

Also to be seen in this section is the "Talymin" fixed-stand comparator and gauge head made by Taylor, Taylor and Hobson, Ltd., of Leicester. This apparatus consists essentially of a gauge head and meter which can be used on machines, on special gauging fixtures, on a comparator stand as shown in our illustration, or on an inspection stand. The gauge head is a hardened and ground steel tube within which is a coil unit and armature designed to convert the mechanical displacement of the gauging tip into an electric signal. This signal is transmitted to the meter for amplification where an ammeter carrying a calibrated meter scale gives a visual reading. Meters are available with ranges from 0·004in to 0·0001in to 0·0005in to 0·00001in, the magnification factors being from 675 to 10,000. A similar range of metric meters and a range of dual scale meters are also available. When the unit is assembled as a comparator with a fixed stand as shown, the distance between the gauge point on the anvil is adjustable up to 6¾in and the throat depth is 3½in.

Another exhibit is a cathode-ray tube instrument, which was designed and made in the Kodak Research Laboratory, for testing camera shutters. Although it was evolved for a special job, being intended primarily for design and development work on camera shutters, the instrument is referred to here because it typifies the way in which electronic techniques can be adapted to the making of measurements that might otherwise be impracticable.

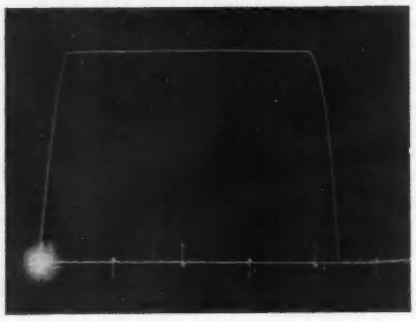
The instrument can be used to test both between-lens and focal plane shutters, as well as to check the correct adjustment of various types of synchroniser used in flash photography and to measure the characteristics of the flash bulbs themselves. It has been found that a testing instrument portraying a characteristic curve of light

transmitted by the shutter against time is preferable to one giving some form of meter indication.

The shutter under test is held on an inclined panel as shown below. When the shutter is operated, light passes through and falls on a photo-electric cell, the output of which is amplified and made to give a vertical deflection of the fluorescent spot on the cathode-ray tube screen. As soon as

SHUTTER TESTING INSTRUMENT IN USE

the shutter starts to open, an electrical pulse from the photo-cell amplifier is applied to a trigger time base circuit, giving a horizontal movement of the spot. These two movements trace the characteristic curve of the shutter. When the fluorescent spot reaches the end of its traverse, it flies back to its waiting position and, in so doing, operates an electronic switch feeding a series of voltage pulses at predetermined intervals



CHARACTERISTIC CURVE OF "COMPUR" SHUTTER SET AT 1/25 SEC.

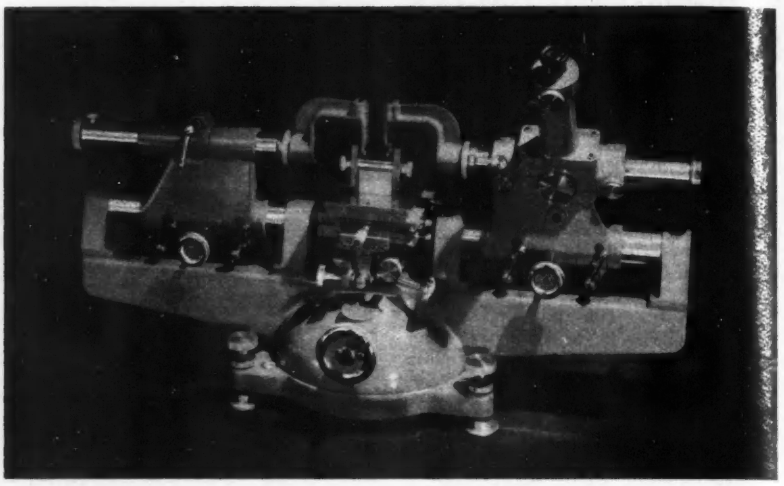
to the input of the photo-cell amplifier. These pulses appear on the screen and the first upward-going pulse again starts the time base, giving a calibration line along the base of the characteristic curve. A typical trace photograph from the screen of the instrument is shown above. It is a characteristic curve of a "Compur" shutter set at 1/25 second. The calibrating marks on the base line are at intervals of 1/100 second, and it can be seen that the exposure time is correct and that only a small fraction of the period of exposure is occupied with the opening and closing of the shutter blades.

By using a cathode-ray tube with an afterglow screen visual assessment of the traces can be made, and it is not normally necessary to take photographs. A number of refinements have been fitted to the instrument in order to make it more convenient in use. One of these improvements enables the brightness of the fluorescent spot to be increased in proportion to its speed of movement, giving a trace in which the nearly vertical parts of the characteristic curve are of the same brightness as the horizontal parts. An additional improvement is a short-duration discharge flash tube fitted above the shutter under test. It may be flashed at any point in the time base, permitting the mechanism of the shutter to be viewed at any instant during its operating cycle. This facility is useful in tracing defects such as shutter bounce and blade lag.

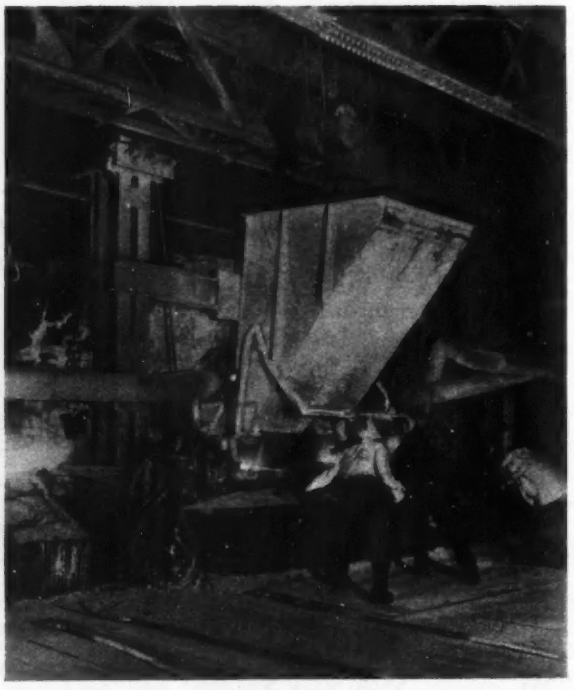
As an example of high precision measuring equipment, one of the horizontal "Microptic" measuring machines, made by Hilger and Watts, Ltd., of London, is exhibited. This machine, to be seen in the illustration above, is designed for measuring external lengths up to 14in and internal measurements from $\frac{7}{16}$in to 10in, and through its optical micrometer readings can be made to an accuracy of 0·00001in.

The instrument consists essentially of a 4in glass scale mounted on a measuring cylinder, which slides freely on ball bearings in the headstock casting. A microscope, in the headstock, is fitted with an eyepiece graticule and an optical micrometer, through which readings on the scale are made. Measurements can be made over a range of 4in for each setting up to the limit of the machine and the measuring system is stated to be accurate to 0·00005in over 4in without the application of any corrections.

The machine is of rigid design and all the main castings are of stabilised Meehanite. The tailstock plunger is carried in a casting opposite the headstock cylinder and the two units are mounted on the casting, which forms the main body of the instrument. Both the headstock and the tailstock are mounted on cylindrical ways, along which they can be traversed by rack and pinion to the required setting and rigidly clamped in position. Mounted in the bed of the machine, midway between the head and tail stocks, is a pillar carrying the floating work-table. Various types of tips and arms can be fitted on the tailstock plunger and the headstock cylinder for external and internal measuring purposes and for threaded work. Measuring pressure, which is about 10 oz, is provided by a



HORIZONTAL MEASURING MACHINE



LOADING A GLASS FURNACE

counter-weight working in an oil dashpot at the back of the headstock.

Before we leave the gallery exhibits to deal with the metal-working section, on the ground floor of the Pavilion, another model of engineering interest should be mentioned. It shows the plant developed and laid down at a cost of more than £1,000,000 sterling by Pilkington Brothers, Ltd., at St. Helens, Lancashire, for the manufacture of polished plate glass. A photograph of the grinding section of this plant is reproduced in Plate 3, and an illustration on this page 710 a batch of the mixed raw materials being fed into the filling-end of the melting furnace. In this plant, which was the first of its kind in the world, the glass is produced in a continuous ribbon from the melting tank to the warehouse—a length of over 1000ft.

The raw materials—sand, soda-ash, limestone and dolomite—are mixed in a mill at one end of the plant and batches of this mix are deposited into skips and the contents fed into the filling end of a gas-fired melting furnace, which has a capacity of approximately 1200 tons, and operates at working temperatures which range from 1430 deg. Cent. to 1530 deg. Cent. At the drawing end of the furnace the molten glass flows in a continuous stream between rollers, which can be spaced to produce the required thickness. From the rollers the ribbon of glass passes on to a roller conveyor system, which carries it through an annealing lehr. When the cooled ribbon of glass leaves the lehr it is inspected carefully before it moves on to the grinding and polishing sections of the plant. In the grinding section the glass ribbon is fed through a series of individual motor-driven grinding units, each fitted with opposed horizontal upper and lower grinding heads between which the glass passes. The heads in each unit are driven at different speeds and, as they rotate, the constant supply of sand and water is fed on to the glass, which leaves the grinding section in a condition of almost perfect flatness. The ribbon of glass then passes into the polishing section, where polishing is carried out in a series of units similar to those used for grinding and smoothing, but using felt-covered heads with rouge and water, instead of sand and water, to impart the high polish associated with polished plate glass. From the polishing section the glass passes on roller-topped tables, where it is cut and taken by overhead sucker crane to the warehouses for examination and cutting to required sizes.

It was in this plant that the polished plate glass ⅜in thick and 50ft long by 8ft high, was made for one of the windows of the Power and Production Pavilion. This glass is claimed to be the largest polished plate glass window in the world.

(To be continued)

HARLOW NEW TOWN EXHIBITION.—The Minister of Local Government and Planning, Mr. Hugh Dalton, recently opened a "Festival Exhibition" at Harlow, Essex. It consists of two parts, the first, a display of models, maps and drawings of the new town, which is housed on the top floor of a nine-storey block of flats. The exhibition outlines the Harlow New Town master plan, the approach to its development and its progress to date. From the balconies of the penthouse above the exhibition, directional diagrams relate works in progress to the architect planner's original proposals. The second part of the exhibition consists of the actual works completed and in progress, which can be approached both by road and the cycle track and footpath systems. Before opening the exhibition Mr. Dalton also opened First Avenue for public use. This is the first section of the new east/west road which will ultimately lead into the town centre.

Britain's Fuel Policy*

By SIR CLAUDE GIBB

QUITE the most depressing, yet stimulating and authoritative, book I have read for many years is that recently published by the Chief of the Conservation Section of the Pan-American Union entitled "Road to Survival." This book draws attention to the serious depletion of the earth's resources during the past hundred years or so, in a manner which should make all thinking people ponder. In the foreword to the book, Mr. Bernard M. Baruch states: "The productivity of much of the earth, through man's mistreatment of it, has fallen to such an extent that what one man-hour of labour could formerly produce, now requires ten, fifty, or even 100 man-hours."

Two years ago it was my privilege to deliver the James Watt Anniversary Lecture to the Greenock Philosophical Society,† and, in so doing, I drew attention to the need to review at once the present policy of fuel utilisation. You, gentlemen—as fuel technologists—are interested in coal, either as a source of energy or as the basis of so much of the chemical industry of the world. It has been estimated that the deep seams of coal now being mined have been forming for approximately 50 to 100 million years. At our present rate of consumption the known resources of coal in Britain will be exhausted in about 200 years. Fifty million years ago a plant in a forest was absorbing solar energy—one month ago that absorbed and stored solar energy was a piece of coal in a Yorkshire pit, one minute ago that piece of coal was fed from the hopper to the grate of a boiler at Kirkstall power station, and at this moment the solar energy absorbed fifty million years ago is with us as energy lighting this lecture theatre.

We should not lose sight of the fact that all forms of energy available to us to-day, in one manner or other, derived their energy source initially from the sun. Hydro-electric power is drawn from falling water that was lifted to the clouds by the heat of the sun. Wind power is derived from the heat of the sun causing inequalities in atmospheric pressure on the surface of the earth. Petroleum is solar energy captured by plants millions of years ago. Any atom which may be split in the dim, distant future was thrown off the sun at the birth of the world.

Vogt, in his "Road to Survival," states: Man is the only organism known that lives by destroying the environment indispensable to his survival. Parasites tend to do this, but their destructive effectiveness is limited by the absence of intelligence. Man uses his brain to tear down." Vogt is dealing solely with the destruction by man of the surface of the earth—of the problems of soil erosion, of forest destruction and the consequent loss of top soil by heavy rain with the inevitable flooding which subsequent river silting must bring.

This evening I wish to stimulate thought on our energy resources which lie below the earth's surface—yet to show how the effective utilisation of coal is so closely associated with agriculture and the world shortage of food, which, according to competent authorities, will become increasingly serious in the years to come.

If the experts are correct—and it really does not matter if they are as much as 100 per cent out in their estimates—in about 200 years there will be no more coal in Britain from which to obtain our heat, our light, our power essential to the maintenance of industrial and domestic life. Can we visualise Britain without coal? Can we think what life would be without electricity, without heat in our homes and factories, without light in homes and streets?

You may think and say that what happens in 200 years' time is no concern of ours and that posterity must look after itself. We laugh when an ostrich buries its head in the

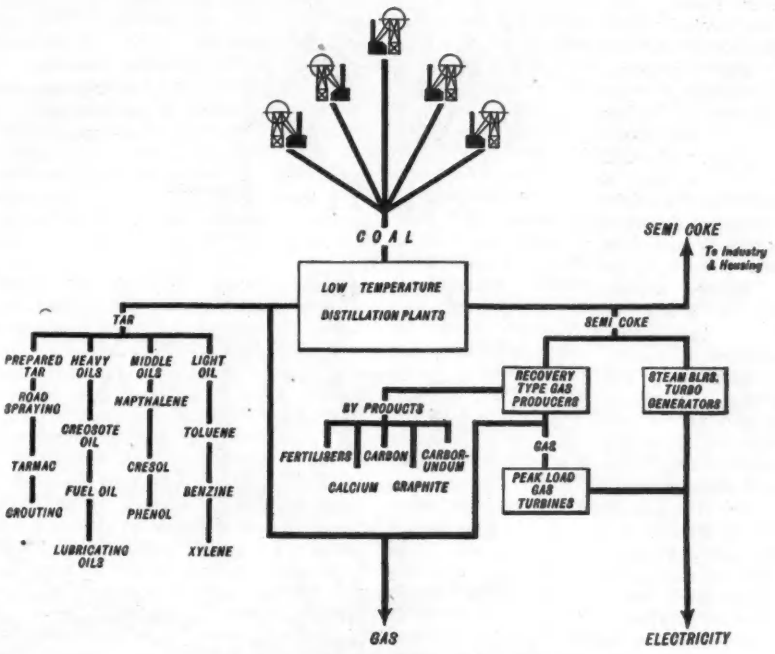


FIG. 1—FLOW DIAGRAM OF COAL PROCESSING

* Lecture to the Yorkshire Section of the Institute of Fuel, Leeds. February 21st.

† See THE ENGINEER, February 4, 1949.

sand to avoid seeing danger—we say it is a stupid bird, anyway. Yet we are being much more stupid than the ostrich, if we refuse to face the facts regarding our coal reserves and their rate of depletion.

It may be thought that long before our coal reserves are exhausted alternative sources of energy will almost certainly have been developed and, again, there is no need for us to do anything about it. Oil has been mentioned as a rival to coal, but world oil reserves are almost certainly of shorter life than those of coal. In any case, oil consumption—like coal—is at a rate fantastically faster than its formation.

Much has been written and spoken on the possibilities of the energy of nuclear fission being harnessed for the production of industrial power. There is no doubt that even to-day we could generate some industrial energy as the result of nuclear fission, but not to have a power surplus after preparing the fissile material and re-treating it for further use. I frankly confess to being one of the many who fail to see other than a severely restricted field of application for what is popularly miscalled atomic power. I do not believe atomic power is going to influence the future generation of energy for industrial and domestic purposes until and unless coal becomes so scarce and expensive that our present ideas of economics are completely thrown overboard.

But, in any case, are we, as intelligent and supposedly sensible people, entitled to go on utilising coal at an average efficiency of only some 15 per cent when at least 30 per cent efficiency of utilisation is open to us to-day if we cared to adopt known techniques?

If the United States Government were to say, "We shall sell to the world our hoarded gold in Fort Knox for the cost of transport and opening the vaults," we should know they were crazy. When Britain sells coal for the cost of opening up her coal vaults and digging and transport—are we any less crazy? Our coal is quite irreplaceable and quite as precious to our future existence as any gold in Fort Knox. We act to-day as we have acted for centuries—as though there were limitless reserves of coal and of oil and of many other things.

Humanity, and particularly is this true of the white races, is and has been living on world resources which are dwindling at an ever-increasing rate. Let us realise that we have been and are living on fat, and that the higher the standard of living, the faster we are eating into world resources or world fat.

I have recently been in India, where to our way of thinking standards of living are particularly low. Yet even the Indian peasants are living on fat to a degree that is only now being realised. The poorest farmer, with his acre or less of land, his cow, goats or water buffalo and his bamboo and mud hut, has always been considered to be almost self-supporting. But to-day that is not the case and for two reasons: first, the reduction of diseases, floods, famine and other checks of Nature which previously stabilised population growth, has demanded that the land should support more people per acre and thus automatically more cattle or sheep per acre, and second, for a less obvious reason, the practice of centuries of drying all animal dung for use as household fuel has so reduced humus in the top soil as seriously to reduce the soil productivity.

If the Indian peasant is to be taught to feed his soil with natural animal humus, he must be given an alternative fuel to his dried animal manure. Whether that alternative fuel be coal, oil or electricity, the peasant must work harder, or longer, to earn the extra money to pay for that fuel. Presumably he then is on the way to having an improved standard of living. If he works still harder or still longer, who knows, but that he may ultimately achieve the standard that we regard as the absolute minimum—he may have a radio set and a brick- instead of a mud-house. But by that time, almost certainly he will have filtered water laid on to him and some form of sanitation. Thus infant mortality will still further fall and the land must carry still more persons per acre. The lesson of India is the lesson of the world.

Science raises the average years of life, population increases at a much faster rate than additional areas of land are brought into food production, and hence the output per acre must be increased. Unless the land receives food, the return per acre will fall and soil erosion become a problem of ever-increasing seriousness.

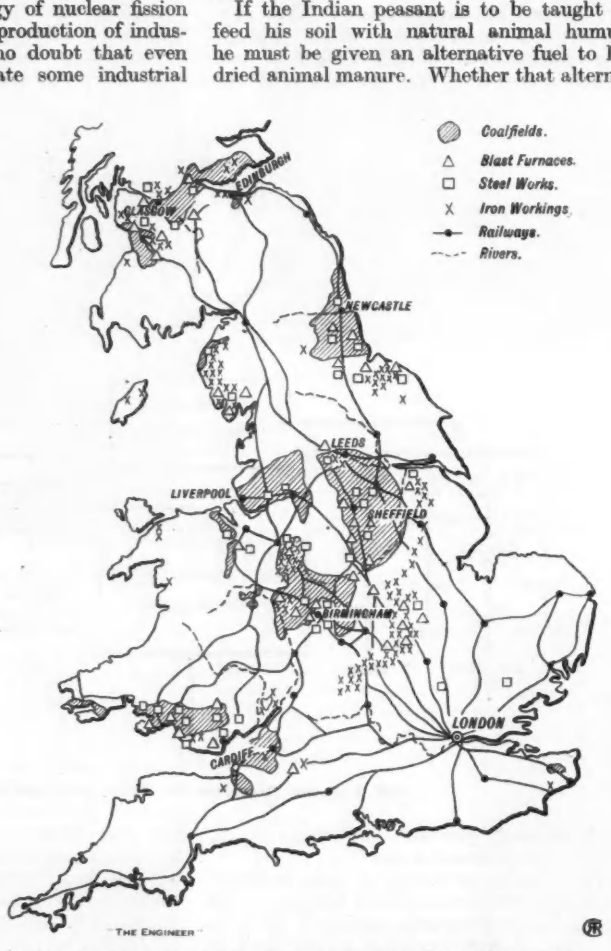


FIG. 2—BRITAIN'S BASIC INDUSTRIES AND RAW MATERIALS

The major need of grassland is the replacement of nitrogen removed from the soil by successive crops. This nitrogen may be provided by ammonium sulphate or nitro-chalk, and could be supplied by coal by-products, which to-day are almost all wasted by our present methods of coal utilisation.

The natural and national source of our energy to-day is coal and it must remain so for many years.

The great bulk of our industrial and domestic power and light comes from coal via steam boilers, steam turbines and electrical generators. The air revolution which Whittle's work on jet propulsion produced has focused popular attention on the gas turbine as a future rival to the steam turbine for driving electrical generators.

Experience already obtained indicates that it is possible to obtain an efficiency and service reliability from a 15,000kW gas turbine equal to a corresponding steam plant provided selected fuels are used. Until the gas turbine can utilise as wide a range of fuels as the modern steam boiler, its field of application must remain restricted. Nevertheless, it may be anticipated that the gas and the steam turbine will, between them, share the field held by power plants of large output, and a neck-and-neck race for efficiency and economy in operation will develop.

For Britain, now and in the foreseeable future, the major source of energy, industrial and domestic, must be based on coal. Britain's fuel policy at present treats coal as a primary fuel. Over the 200 million tons of coal used annually in Britain, the average efficiency of utilisation is only some 15 per cent, and it will remain at approximately that figure so long as we follow our present fuel policy.

The electricity industry, the gas industry, British Railways and domestic users are all treating coal as an inexhaustible source of energy which costs us nothing beyond the vault opening, the digging and the transporting. All buyers of coal are endeavouring to utilise it more efficiently—not in an endeavour to conserve our precious national asset, but merely because coal has increased so much in purchase price. Let us realise that coal has not increased in value—its calorific value has not increased. The only thing that has increased is its purchase price—and its ash content! In other words, it is to-day costing more in money to open the vault and dig out our black gold.

If we were sensible, wouldn't we attempt to get more out of our black gold because we have to pay more for it? But we are not. The policy which regards coal as a primary fuel instead of a precious and dwindling chemical is no policy at all. It is the policy of the illiterate peasant of India who burns the precious soil humus which alone can stop him or his children from starving.

During the past fifty years many distinguished engineers, scientists, committees or Royal Commissions have studied, considered or proposed methods of coal conservation. Many proposals for coal processing have been made. Outstanding amongst them were those submitted by the late Mr. Charles H. Merz. Tyneside may rightly claim to have given the lead to Britain and to the world in the matter of efficient coal utilisation.

At the instigation of Mr. Merz, pilot coal distillation plants were operated at Neptune Bank and Dunston and were followed by a full-scale plant at the Dunston "A" power station operated in conjunction with steam-raising boilers for electricity generation.

In the first super-power station of Britain, designed under Mr. C. H. Merz, that of Barking "A," provision was made in the original lay-out for adding a coal distillation plant ahead of the boilers.

The Dunston "A" distillation plant was ultimately dismantled, and the Barking "A" proposals abandoned—not because of any technical difficulties, but because the scheme was ahead of dire necessity. During that period (1919–1933) coal reached its lowest price—there was a world surplus of oils and spirit—agriculture in Britain was at a low ebb and sulphate of ammonia a drug on the market. There was no sale for creosote and little for tar. The chemical industry had not developed and large-scale grouping of electricity and gas generation was only beginning.

The position to-day is entirely different. Coal is at its highest price ever; imported fuel oil has advanced in price and is in world short supply as well as requiring dollars for its purchase. Agriculture requires more and more fertilisers to reduce the drain on our pitifully inadequate dollars; the chemical industry is expanding rapidly; the national economic situation demands immediate action. We must conserve our dwindling coal resources.

Coal has been nationalised, the electricity supply industry also, so has transport and gas, and now is the moment to integrate those four great industries, all of them depending on our most important national asset—coal.

It is almost certain that by looking at coal as a national asset and regarding gas, transport and electricity as one national undertaking, we could in, say, twenty years, obtain the same amount of light, heat and power from about 120 million tons of coal as we now obtain from 200 million tons. To do so would require a huge amount of capital expenditure which no one of the nationalised industries individually could justify, but which, looked at as a long-term national problem of the next fifty years, is absolutely vital to the continuance of Great Britain as a Great Power. It is, indeed, likely that in less than fifty years we shall only be raising about 120 million tons of coal per year.

We can all remember the years 1930 to 1938, when posters covered the hoardings reading "Use More Coal," when the coal industry established research and publicity organisations in an endeavour to increase the sale and use of coal. Those days are gone for ever. It is certain that in the future we shall always be struggling to obtain sufficient coal to maintain industrial and domestic energy supplies. The rate of increase in the demand for electricity is such that by 1960 the annual coal consumption for electricity generation will be about 50 million tons as against the present 30 million tons. As our standard of living increases so does the rate at which we consume irreplaceable world resources. If it is within our power to reduce the annual inroads to our dwindling national reserves, we owe it to our children and to their children to come, that we do so. This is not a matter of selflessness and high ideals, it is just plain commonsense. The skimming of the rich cream must stop.

How can we make 120 million tons of coal do the work now requiring the consumption of 200 million tons? The answer is to follow and expand the lead given by that great engineer, Mr. C. H. Merz, who was thirty years ahead of necessity in his vision. Mr. Merz foresaw the need to regard with horror the burning of raw coal as a primary fuel. He foresaw the need for main line railway electrification, the extension of electricity generation and the need for super-power stations. He realised the value of coal distillation by-products.

Had a German bomb not destroyed the life of that brilliant and far-sighted engineer I feel that the advocacy of his own policy of the "'twenties" would have brought about by now the adoption of a more rational fuel policy in Great Britain.

Few will deny that electricity is supreme in the supply of rotary power and in lighting. It wins on efficiency, cost, cleanliness and low maintenance. When, however, we come to heating, whether industrial or domestic, the position is by no means so clear. Even were all electricity generating stations of the latest design and efficiency, heating by electricity could not give an efficiency of coal utilisation higher than 30 per cent unless thermal electric stations and district heating is adopted on a large scale.

Gas heating, however, could readily achieve a coal utilisation efficiency of at least 50 per cent and probably nearer 60 per cent. Additionally, gas has the advantage of being able, within limits, to be stored and thus gas-making plants need only be built to deal with average demands and not peak demands as with electricity. Further, gas-making plants nowadays recover the great bulk of the coal by-products which direct coal burning prevents.

A strong case can be made for off-peak or night electric hot water storage heating for background temperatures, but the open-bar type electric radiator used during a peak load period is a wickedly extravagant thing, which, like the open coal fire, should be banned or made so expensive to use that its use would quickly be eliminated.

The solution is to use electricity where it is the most efficient and economic form of energy and to use gas where gas is supreme, and that is mainly in industrial and domestic heating. I do not believe there is any place for coal, coke or fuel oil as direct sources of industrial or domestic energy, whether for lighting, heating or power, except in special and isolated cases.

The domestic consumption of coal in Britain to-day is just under 40 million tons per annum, with an overall efficiency of burning little over 10 per cent. Had we processed that 40 million tons of domestic coal we should have obtained as by-products 100 million gallons of benzole and 660 million gallons of crude tar, which, after further distillation or hydrogenation, would provide with the benzole 25 per cent of the oils and spirits consumed in Great Britain in 1947. Additionally, there would be available over 1000 million therms of heat in the gas produced by that processing, or one-third of Britain's 1947 gas consumption. The total value of these by-products is well over 50 million sterling. But after that processing we should still have remaining 30 million tons of semi-coke which would light just as readily as coal in the ordinary household grate and would, because of its greater radiant heat, be equally effective in household heating as the 40 million tons of raw coal. Finally, the reduction of damage to health and property which would result, would give a further return of at least £25 million.

In 1947 we consumed (excluding bunker fuel) about 10 million tons of oils and spirits. Had we processed all the coal raised in Britain in 1947 we could have obtained between 8 and 12 million tons of home-produced oils and spirit by distillation and hydrogenation of residues.

With our national finances in the parlous state they now are, how can we go on ignoring these facts? It has been said to me that because Ministers change—and even sometimes Governments change—it is not possible to lay down any policy for more than a few years ahead. What utter nonsense that idea becomes when we are to-day building power stations which will have a life of at least thirty years and thus are laying down a fuel policy for thirty years ahead. The tragedy is that our present fuel policy is wrong and could not be rectified fully for at least thirty years even if we started to-day.

Fig. 1 shows the solution which I am certain will be adopted before very long and I hope before it is too late. There is nothing new in the proposals—nothing that has not already been demonstrated to be technically sound. For the time being and until industry and our houses are modified to cater for and use only gas and/or electricity, there will be the third source of heating, viz., semi-coke. As the demand for semi-coke falls, there will be an increasing demand for electricity and gas which will be met by the installation of further recovery type gas producers and either additional gas turbines or more steam boilers and turbo-generators. Such a scheme gives the maximum of flexibility in dealing with a wide variety of coals and with fluctuating demands of gas, semi-coke and electricity.

We have some eight major coalfields in Britain and, as a natural consequence, industrial areas have developed reasonably near to most of these. Fig. 2 is a composite map showing the important coalfields, iron ore mines, blast-furnaces, steel works and railways. This shows in striking manner the growth of basic industries in relation to their essential raw materials.

By siting coal-processing plants reasonably adjacent to the geographical centres of these major coalfields—always having in mind the gas and electrical demands of the surrounding areas and the necessity to have adequate water supplies close at hand—we could bring our coal transport problem to its smallest dimensions, and, by grouping by-product recovery plants, base load semi-coke-fired electrical power stations and low calorific value gas-fired gas turbines to cope with peak loads, we could achieve national economies which would be startling.

The map shows that a large proportion of our total population, which is centred in our industrial areas, would be served by relatively short gas and electricity grids radiating from the main coalfield generating plants. London and South-East England will always be a special problem and need special consideration and treatment. The existing and future power stations of Greater London could all be fired by the semi-coke residue of coal distillation with at least equal efficiency and certainly less atmospheric pollution. Sea and, therefore, relatively cheap haulage of suitable coking coal to London's gasworks will probably continue, but this is in accordance with the overall policy proposed since that coal would be efficiently treated with full by-product recovery.

In our changed and changing economic situation, food will become a major factor—probably the major factor of the future. It is in food production that coal and its by-products can play such a decisive part. Britain is an outstanding example of the necessity to increase greatly our home food production. This for two reasons—first, our continuing inability to pay for additional imported foods to maintain or improve our existing living standards, and, second, the fact that overseas countries will very shortly find it impossible to export to us those foods

we need, since their own increased populations are consuming all their production.

A great expansion of British agriculture is vital to our future. Coal processing can play a major part in that expansion. The by-products of sulphuric acid and ammonium sulphate will all be needed to help provide fertilisers on a scale undreamed of in British farming to-day. It has been estimated that, by increasing the present average usage of nitrogenous fertilisers by seven times, the number of cattle and sheep carried per square mile could be increased fivefold. As the efficiency of animal conversion from grassland to meat, butter, cheese, &c., is only some 20 per cent, the fivefold increase would provide at least the same number of food calories intake, but with the variety of food we so desperately need. By adopting this policy we could again enjoy our steaks!

It may well be found that the available market for semi-coke for electricity generation and for the reorganised domestic and industrial heating is far below the quantity of semi-coke that would be produced from a universal adoption of low-temperature distillation. In that event completely destructive distillation could be adopted for surplus semi-coke yielding more gas and a wider range of by-products and a very large yield of ammonium sulphate. The processes available for coal distillation are capable of adjustment over wide ranges as from process to process and there would be no difficulty in arranging a balance between the products produced and market demand for those products.

The fact that there is a heat loss in all forms of coal processing does not invalidate the arguments for such processing.

Let us forget the sensationalism of the Press in its promise of industrial atomic power within the next ten years. Let us realise that we are to-day perpetuating a wrong fuel policy to last the next thirty years. Let us look at the whole problem of coal utilisation in its field of domestic and industrial use and in the electricity, gas and transport industries. Let us appreciate the vital needs of agriculture. Let us have courage to look fifty or 100 years ahead and make our plans to-day during a period of full employment so that those plans may be put into effect as other employment falls—as, indeed, it will—and we then can really promise full employment to the nation in the knowledge that money otherwise paid out by the dole will be employed in creating a national fuel policy in which coal is regarded as a precious chemical and our only source of energy capable of bringing an enhanced standard of living to the nation.

International Motor Show at Frankfurt

(Continued from page 678, May 25th)

No. II.—COMMERCIAL VEHICLES

OUR report of the first German post-war motor exhibition continues with a short survey of commercial vehicles, which, in contrast to the more international character of the passenger cars shown, were all of German origin. In some respects the display of commercial vehicles, of which there were over 500, was more impressive than that of the passenger cars, and it provided clear evidence of the vigour of this renascent German industry, particularly in its range of heavy goods vehicles and public service vehicles.

The design of German light commercial vehicles and delivery vans follows conventional lines; it is usual to convert for this purpose normal passenger car chassis, utilising as far as possible standard parts of the body assembly. The Daimler-Benz Mercedes 1·77 litre diesel chassis, for instance, is frequently fitted with a box-van body as are the Opel, Ford and Borgward models. More interesting, probably, from a technical point of view, are the light vans up to 15 cwt loading capacity shown by the various firms specialising in the manufacture of the less orthodox types of passenger cars, such as the Volkswagen Works, the Auto Union, Goliath, Lloyd, Gutbrot, &c. Here, again, certain parts of the respective passenger car models have been retained, such as the air-cooled or two-stroke engines, rear-engine mounting, front-wheel drive, &c., but the lay-out of the chassis has been altered, in some cases considerably, to meet the conditions of a different load distribution. An interesting example of such a vehicle is the Gutbrot "Atlas" 16 cwt delivery van, equipped with a very neat air-cooled 600 cc. two-stroke engine, mounted at the rear of the chassis (Fig. 8), and fitted with chromium-plated aluminium cylinders. Vehicles of this and of similar design with a chassis weight of generally less than 16 or 17 cwt, are fitted from a range of bodies and, being economical in service, are popular for local delivery work.

Few innovations were noted in the middle range of commercial vehicles, i.e., those from 1·5 to 4 tons loading capacity, but it was apparent that all manufacturers, with the exception of Ford and Opel, nowadays equip these vehicles with diesel engines. The smallest units at the show were a 2·8 litre four-cylinder Hanomag diesel of 50 h.p. in a 1·75-ton chassis and a 3·3 litre four-cylinder Borgward diesel of 60 h.p. in a 2-ton lorry. Notable amongst the 3·5-tonners was the Mercedes "L3500," a fast and flexible vehicle with an interesting six-speed transmission with four ratios constantly in mesh. It has a 4·6 litre six-cylinder diesel engine, developing 90 h.p. at 2800 r.p.m., and the weight to power ratio is only 8·7 lb per horsepower. Another attractive vehicle in this group was the Magirus "S3500," fitted with a five-speed gearbox and powered by the air-cooled 5·3 litre Deutz engine, which was fully described in our issue of April 6, 1951. All these medium-weight vehicles are capable of travelling at 50 m.p.h. and frequently operate with two trailers.

In the category of heavy goods vehicles the platform truck, carrying a payload of something between 5 and 6 tons, still maintains its predominant position. The recent Geneva convention, however, permitting higher axle loadings, has promoted a definite tendency towards vehicles with a loading capacity from 7 to 10 tons, a number of which were exhibited. All these vehicles, with the exception of the Faun 6-ton and 8-ton trucks, which, optionally, can be supplied with forward control, have the orthodox bonnet. Practically all trucks are also built with a short wheelbase as tractors to operate with semi-trailers, a conveyance widely used in U.S.A., which is becoming increasingly popular on the Continent, particularly for reciprocative hauling jobs. In this class of vehicle are the M.A.N. 8·5-tonner and the Kaelble 9-tonner, both fitted with eight-cylinder Vee diesel engines of 180 h.p. and 200 h.p., respectively, the 8-ton Magirus, powered by the new eight-cylinder, air-cooled 175 h.p. Deutz engine and the 8-ton "Titan" of the Suedwerke, which is equipped with a 210 h.p. straight six-cylinder two-stroke engine. All

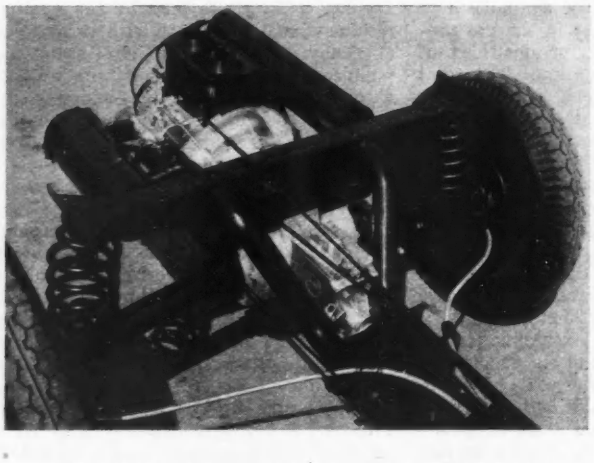
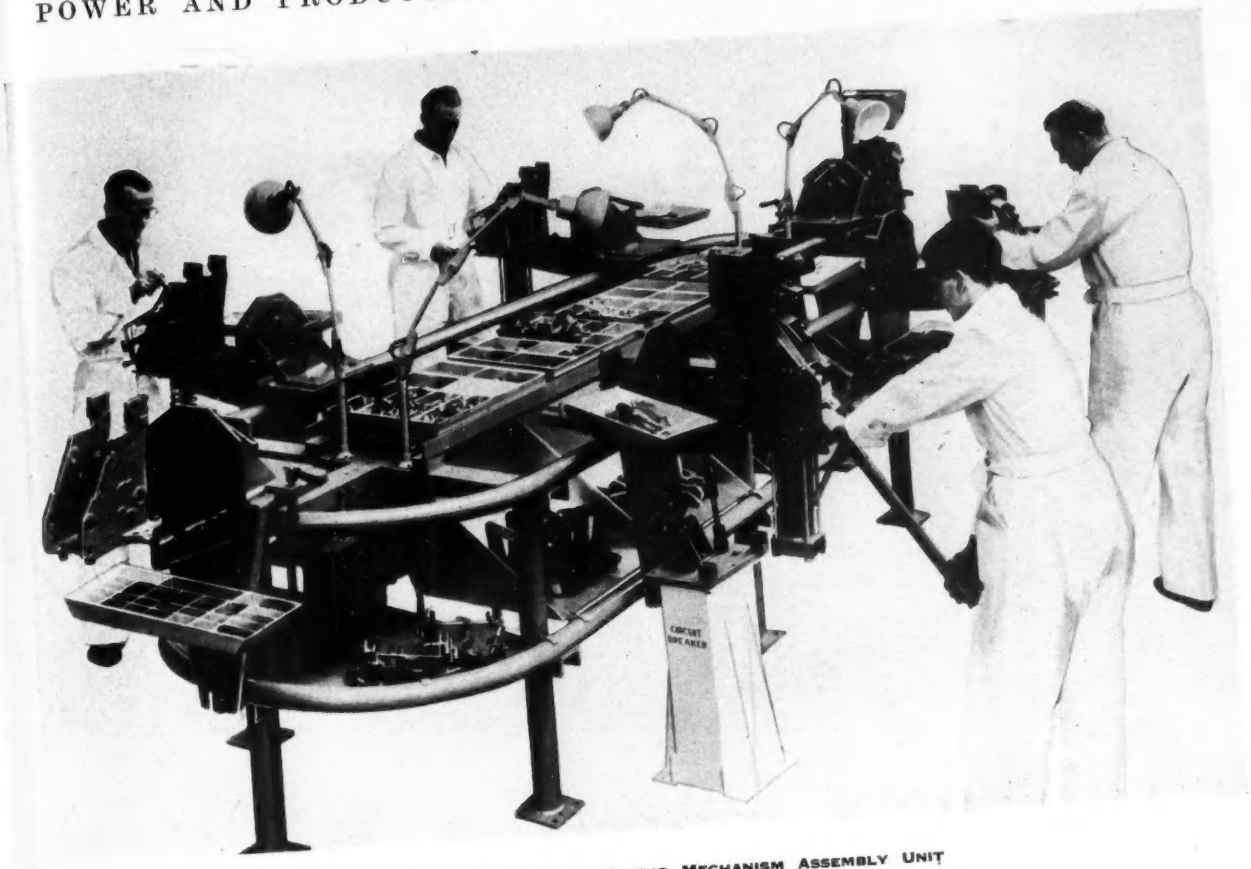


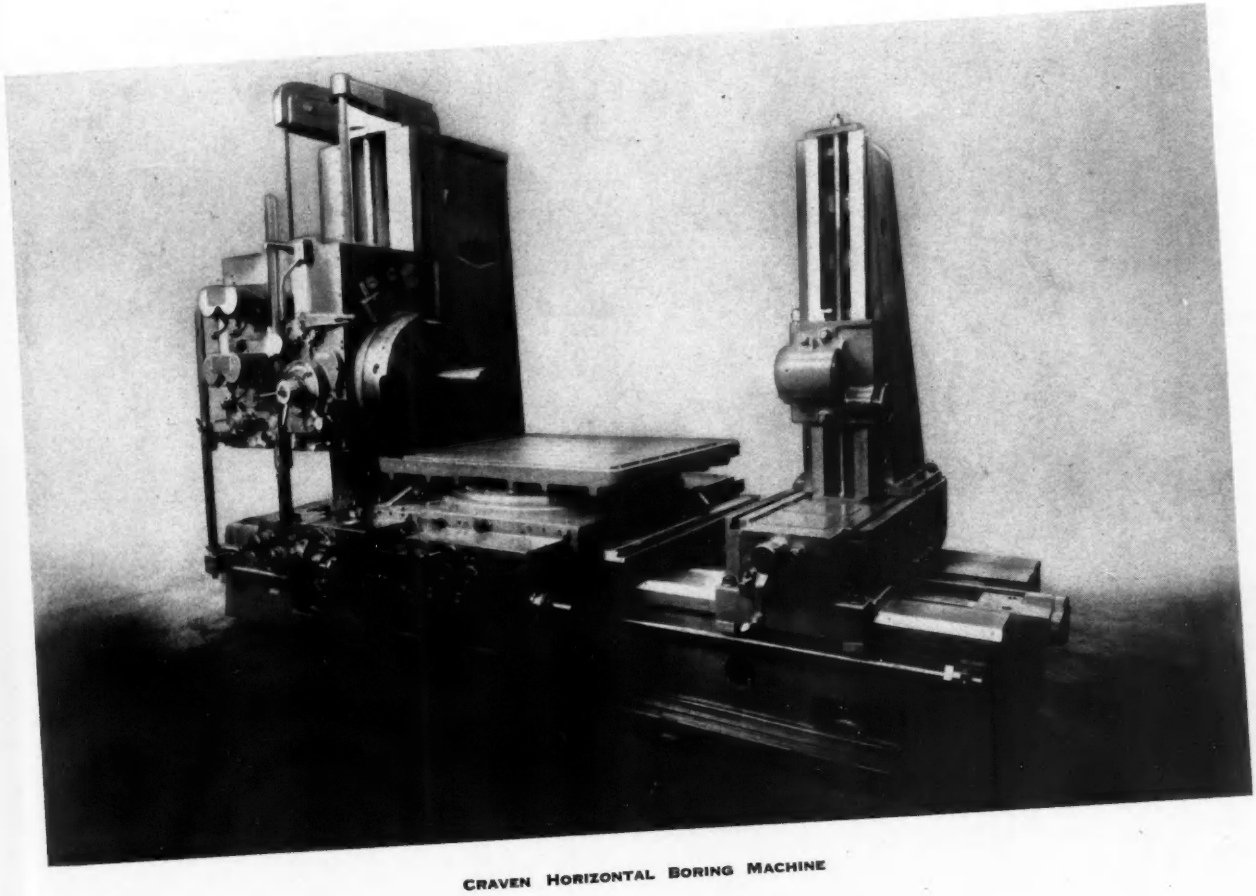
FIG. 8—AIR COOLED TWO STROKE ENGINE ON "ATLAS" CHASSIS—GUTBROT

FIG. 9—175 H.P. SIX CYLINDER UNDERFLOOR DIESEL ENGINE—BUESSING

POWER AND PRODUCTION AT THE SOUTH BANK EXHIBITION



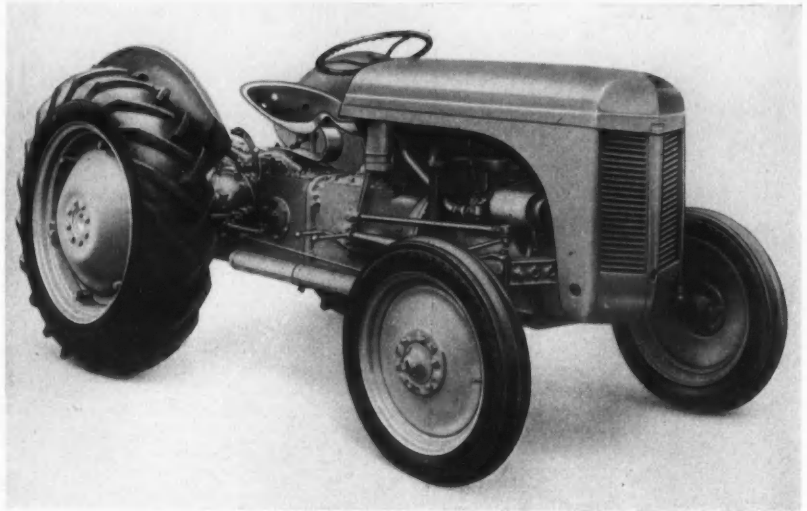
REYROLLE SWITCHGEAR OPERATING MECHANISM ASSEMBLY UNIT



CRAVEN HORIZONTAL BORING MACHINE

AGRICULTURAL TRACTORS AT THE SOUTH BANK EXHIBITION

FORDSON "MAJOR" TRACTOR



FERGUSON TRACTOR

NUFFIELD "UNIVERSAL" TRACTOR

DAVID BROWN "TRACKMASTER" TRACTOR

these vehicles are four-wheelers, designed for long-distance operation with two trailers, the total gross weight of the whole combination in some cases being as high as 40 tons. In this connection it should be mentioned that the use of more than one trailer, so far permitted in Germany under an emergency law, is to be discontinued from November 1, 1952, so that the long-distance vehicle of the future will probaby be a 12-ton truck

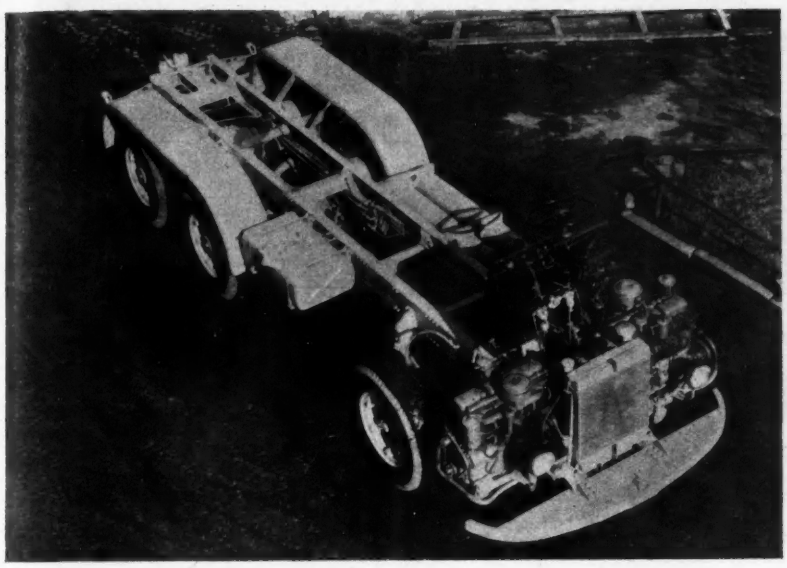


FIG. 10—TRACTOR WITH TRANSVERSELY MOUNTED ENGINES—HENSCHEL

or tractor to operate with a trailer or semi-trailer carrying a total payload up to 24 tons.

An interesting example of this class of truck was exhibited on the stand of Buessing. The six-wheeled, 12-ton vehicle is powered by a 13·5 litre underfloor engine, developing 175 h.p. at 1600 r.p.m., and is notable because of the neat and accessible arrangement of the auxiliaries (Fig. 9). The radiator is positioned at the front of the vehicle and the fan-drive can be disconnected by means of an electromagnetically operated friction clutch, which is controlled from a thermostat in the cooling-water circuit. The torque is transmitted from the six-speed main gearbox to an auxiliary gearbox and from there through two propeller shafts to the centre and rear axles. This heavy unit, weighing in chassis form 8·5 tons, requires an air-operated servo steering device.

The Henschel heavy-duty tractor is another six-wheeler, which has the same rather original engine arrangement as the "Bimot" bus by the same firm (Fig. 10). Two 5·4 litre engines of 94 h.p. each are mounted in line transversely ahead of the front axle and are coupled together to one common bevel gear. The torque is transmitted from the bevel gear via a four-speed gearbox and an additional two-speed transfer box to the propeller shaft and to the centre and rear axles, which employ worm gears (a notable exception in German automobile engineering), in conjunction with simple reduction gears. The axles are suspended from four longitudinal springs, arranged in pairs on either side of the frame members, so that they allow a slight rotation about a tubular cross member. In order to minimise torsional stresses on the springs, due to reaction torque, multiple rubber discs are interposed between the axles and springs. In addition to the usual air-operated brakes, the vehicle is fitted with a simple engine brake, consisting of a throttle in the exhaust manifold. With a four-wheeled trailer and a resultant gross weight of 30 tons, it is claimed that the tractor can climb a 1 : 5 gradient at a speed of about 40 m.p.h.

All these heavy vehicles are designed to travel at an average of not less than 45 m.p.h., for which the engines are required to withstand prolonged periods at almost continuous full load. The Frankfurt Show indicated that, as far as detail design goes, great progress has been made in Germany in the improvement of pre-war diesel engines, sometimes of a rather unorthodox character. German motor manufacturers have clearly profited from research undertaken a few years before and during the war, and particularly in the design of new two-stroke engines, in the adoption of air-cooling for engines of quite considerable output, in the construction of supercharged engines, and in the general tendency towards higher engine speed.

The pre-chamber engine still dominates

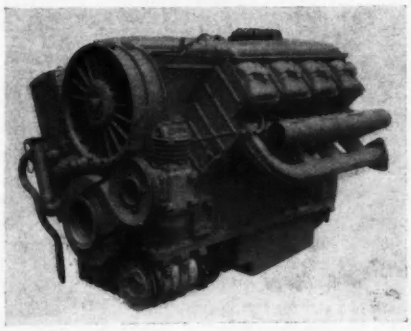


FIG. 11—EIGHT-CYLINDER ENGINE—DEUTZ

though in modified form; the pre-war pre-combustion chamber with several small holes to the cylinder room proper is confined to-day to cylinder bores of more than 110mm and, in smaller units, it has been replaced by some sort of swirl chamber (comprising about 50 per cent and more of the total compression room) with one wide communicating passage. As a result of the reduced heat losses in the transfer ports, these modern engines are easier to start at low atmospheric temperatures and the fuel consumption is now in the region of 0·380 and 0·400 lb per horsepower, a reduction of about 10 per cent compared with pre-war figures. The speed of German diesel engines, as a rule, is about 10 to 15 per cent higher (average piston speed 2000ft per minute) and the weight and size correspondingly smaller than that of British engines of equivalent output. German motor manufacturers claim that, by the employment of better wear-resisting material and of detergent lubricating oil, coupled with chromium-plated piston rings, the major overhaul life of engines has been extended to such a degree that even a further rise of engine speed seems justified, providing it continues to reduce engine weight and bulk.

The general lay-out of the majority of German diesel engines, as exhibited at the Frankfurt Show, does not differ to any large extent from that of this country. Thin-walled, steel-backed bearings are not used yet for main bearings, but they are tentatively employed for the big ends. Wet cylinder liners are the rule and slip-fit liners, as frequently used in British engines, have so far found no application in Germany, as they are supposed to obstruct the heat flow to the cooling medium. Inlet and

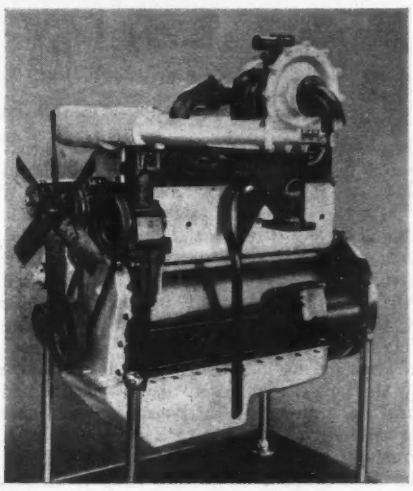


FIG. 12—SIX-CYLINDER ENGINE—M.A.N.

exhaust ports are generally located on opposite sides of the cylinder head to reduce preheating of the intake air by the exhaust manifold. For the same reason the air-intake is generally extended by a pipe leading from the air-filter direct to the atmosphere. Thermostatically controlled oil-coolers in the water circuit are frequently used and much attention has been given to the promotion of crankcase ventilation.

For an output of up to 150 h.p. the straight four or six-cylinder engine is the rule, but the compact and well balanced eight-cylinder Vee 90 deg. unit is gaining favour for the bigger units. This applies particularly to buses with rear engine-mounting (a construction which apparently is becoming popular in Germany nowadays), for which purpose the short Vee-eight is indeed the ideal power unit. Owing to the generous proportions of heavy commercial vehicles, permitted by law practically everywhere but in this country, no particular difficulties have been encountered in accommodating these large engines under the bonnet of a truck or at the rear of a bus.

Of all the various exhibits but a few engines can be mentioned, which, by virtue of their general lay-out or because of their

detail design, seem to be particularly interesting.

The range of air-cooled engines made by Kloeckner-Humbold-Deutz has been extended by a new 10·6 litre eight-cylinder Vee 90 deg. engine, developing 175 h.p. at 2250 r.p.m., which is entirely built up from standard cylinder units as used in the four and six-cylinder engine. The axial blower with its cooling-air duct is arranged between the two cylinder banks, as is the injection pump. The engine (Fig. 11) has very clean lines and is pleasing in appearance. On a short test drive the engine noise seemed far less disturbing than was anticipated and would not be objectionable in public service vehicles.

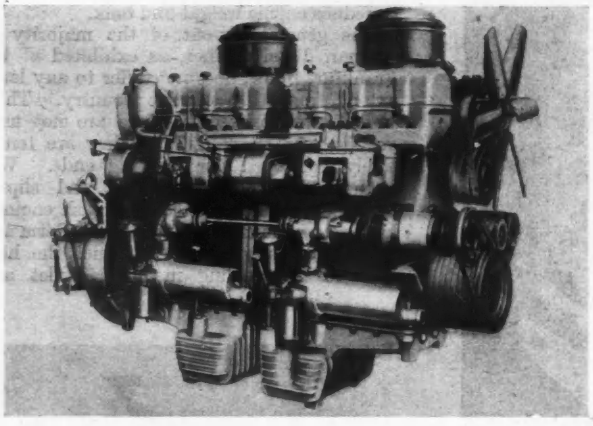


FIG. 13—SIX-CYLINDER ENGINE—SUEDEWERKE

M.A.N. showed a 130 h.p. six-cylinder engine of 8·7 litre capacity, a supercharged version of the same model, and an 11·6 litre, eight-cylinder Vee 90 deg. engine. All units are identical in their cylinder dimensions and have direct injection. The single-hole injector with plane needle seat is arranged at an angle of 30 deg. relative to the cylinder axis and discharges the fuel into an almost spherical chamber, recessed in the light-metal piston. The supercharged version (Fig. 12) is fitted with an exhaust turbine coupled to a centrifugal blower, which gives a boost pressure of about 6 lb per square inch. The air-pipe from the blower is made of aluminium and is heavily finned in order to reduce the intake temperature. The mean effective pressure at maximum speed is about 130 lb per square inch, and the output of 175 h.p. at 2000 r.p.m. is almost the same as that of the considerably bigger, and more than 200 lb heavier, eight-cylinder engine. The turbo-blower, of course, is less responsive to rapid changes of engine load than a mechanically-driven blower and presumably this new arrangement will be mainly used for long-distance vehicles travelling under conditions in which the engine load does not change very much.

It was to be expected that the Germans as a logical development of their aim to build high-powered engines of compact design, would show some new two-stroke engines. The Suedwerke, a firm associated with Fr. Krupp, which, before the war, made Junkers opposed-piston engines under licence, showed its latest two-stroke engines, which in their general conception, somewhat resemble the British Foden engines. Two basic models are being made, a three-cylinder and a four-cylinder unit, of 4·35 litre and 5·8 litre, respectively. The six-cylinder engine (Fig. 13) developing 210 h.p. at the comparatively low speed of 1700 r.p.m., consists of two suitably modified three-cylinder units, the cylinder blocks of which are rigidly bolted together; the crankshafts also are positively coupled by the engagement of interlocking teeth.

The engine employs uniflow scavenging with tangential inlet ports at the bottom of the cylinder and two exhaust valves in each cylinder head, operated by short push-rods from a camshaft located in the cylinder block, slightly above the inlet ports. A multi-hole injector in the centre of the light-metal cylinder head discharges the fuel into an open cardioid-shaped combustion chamber, recessed in the aluminium piston. The scavenging pump is a two-lobe blower of the Roots type, driven by a multiple Vee-belt from a pulley at the forward end of the crankshaft. The torque, 125lb ft per cylinder at 1100 r.p.m., is higher than that of any other engine at the show.

Also of interest was the Krauss-Maffei two-stroke, four-cylinder Vee 90 deg. engine of 5·88 litre capacity, developing 145 h.p. at 2200 r.p.m. Though not actually exhibited on the stand of Krauss-Maffei, it could be examined in a demonstration bus of this firm, mounted at the rear of the vehicle in the longitudinal position. In contrast to the engine of the Suedwerke, the Krauss-Maffei engine, which has direct injection, uses a loop-scavenging system similar to that employed in the majority of German motor-cycle engines and small car engines of the two-stroke type. It has a centrifugal blower, driven by a train of gears from the forward-end of the crankshaft, which discharges the air into a receiver recessed in the crankcase between the two cylinder banks.

FIG. 15—ENGINE SUB-FRAME—FAUN

The application of a centrifugal scavenging blower to road engines seems an attractve development. On the other hand, owing to the limited pressure developed by a centrifugal blower at low speeds as compared with a positive-displacement blower, it would appear that the available engine torque in the low speed range will be reduced.

The lay-out of the Krauss-Maffei engine with its short two-throw crankshaft, is simple and very compact; the arrangement of the cylinders allows the balancing of the primary inertia forces of each cylinder pair; the primary couples of the whole system are balanced by rotating masses which, in order to save weight, are not attached in the usual way to the crank-webs but outside the crankcase, to the front-pulley and to the flywheel. Although the b.m.e.p. of 72 lb per square inch is lower than that of modern uniflow engines, the simple valveless design offers certain attractions.

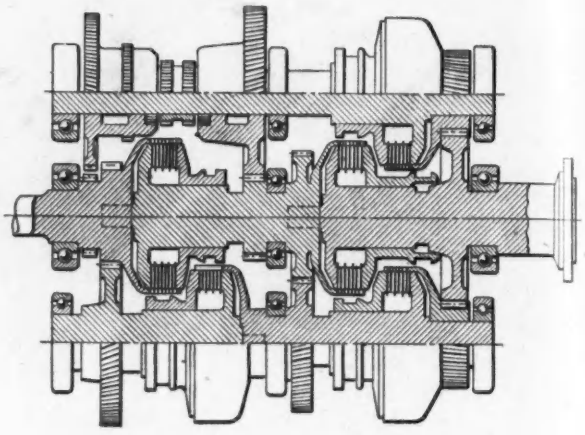


FIG. 14—MULTI-FRICTION CLUTCH GEARBOX—Z.F.

There was little of unusual interest about the design or construction of power transmission units for commercial vehicles. Constant-mesh gearing is usual except for the lowest gears; single helical gears are generally employed for the constant mesh and straight spurwheels for the sliding gears. There were some vehicles with pre-selective auxiliary gearboxes, giving a total of up to ten gear ratios, but the majority of heavy public service vehicles were fitted with six-speed gearboxes.

The growing tendency towards buses with rear-engine mounting has created a certain demand for gearboxes which can be easily operated by remote control. The Zahnradfabrik Friedrichshafen (Z.F.) had an electro-magnetically operated gearbox on show in which all six gears are electrically clutched; the box also contains an emergency direct gear for tow starting with flat batteries and a mechanically selected reserve gear which can be used for parking on gradients.

Another Z.F. gearbox, also operated by electric control and fitted on several of the rear-engine coaches exhibited, has six speed ratios in constant mesh like the electro-magnetic gearbox, but they are fitted with multi-plate friction clutches, running in oil, and the appropriate gear ratio is engaged by a follower, actuated by a control cylinder, the circumference of which contains several cam-shaped grooves (Fig. 14). A small electric motor with a double reduction gear, fitted outside the gearbox casing, is electrically connected with a selector lever, attached to the steering column, and turns the control cylinder into the required posi-

tion. The normal main clutch is used when moving away from rest, but subsequent gear changes are made by shifting the selector lever without depressing the clutch.

Probably the most interesting part of the Frankfurt exhibition was the display of public service vehicles, which showed an almost general departure from the German traditional design as applied to the conventional bonnet-type bus. Bus traffic in Germany has developed greatly since the war and is being actively encouraged by the State Railways and the Post Office authorities, which operate a considerable number of medium and long-distance bus routes. All German public service vehicles are two-axled, single-deckers, with the maximum legal length of about 37ft and a width of 8ft 3in, carrying forty-six passengers in long-distance travel and up to forty passengers seated and fifty standing in city buses. In short-distance travel, whenever road conditions permit, trailer coaches, carrying up to fifty passengers, are employed, especially during the peak traffic hours.

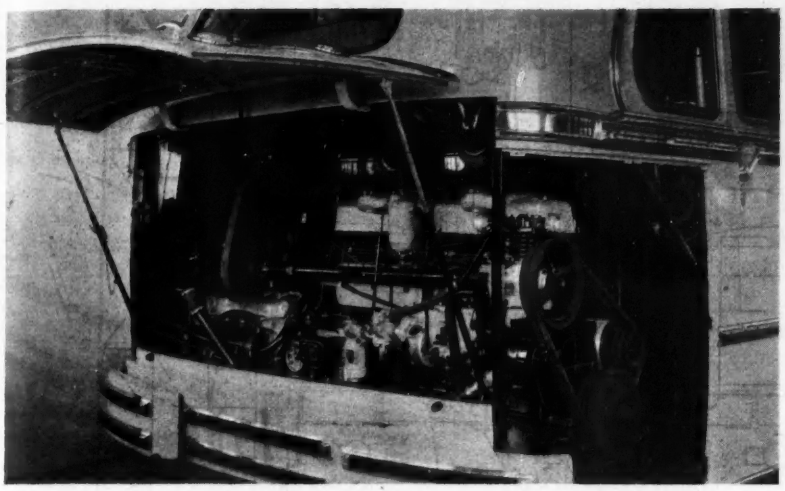


FIG. 16—REAR ENGINE MOUNTING IN MERCEDES BUS

There were, of course, still a considerable number of the orthodox bonnet-type vehicles on show, particularly in the light and medium class of buses, but all major manufacturers had introduced some new model with a less conventional space-saving engine mounting. Of these were the Faun forward-control bus, the complete power unit of which is mounted on a sub-frame, which can be pulled out from the front of the vehicle (Fig. 15), the Buessing "Trambus," the only German coach fitted with an underfloor engine, and the Henschel "Bimot" which, like the previously described Henschel 12-ton tractor, is equipped with two transversely mounted 84 h.p. engines ahead of the front axle.

All the other firms, however, have mounted the power unit behind the rear axle; Ford, Krauss-Maffei, Magirus, M.A.N., and Rathgeber mount the engine longitudinally, parallel to the centre line of the vehicle. Daimler-Benz transversely, parallel to the rear axle.

The almost unanimous adoption of the rear engine mounting by the German manufacturers seems strange, particularly as this design, with a long six-cylinder engine longitudinally mounted high in the chassis, restricts the seating capacity to some extent. Looking at the rear engine coaches, operated by the State Railways in the Frankfurt district, it was observed that the platform space required was hardly smaller than that of an engine mounted in the orthodox way under a bonnet, and it was thought dubious whether such a design justified the complications involved by the remote operation of clutch, gearbox and engine control. Some of the more recently developed models, exhibited at the show, have overcome the shortcomings of earlier designs, emphasising at the same time two very definite advantages of the rear engine system—a floor-level considerably lower than that attainable with underfloor engines and the large luggage capacity between the wheels.

M.A.N. mounts the 130 h.p. engine very low in the chassis and set at an angle of about 30 deg. to the vertical, so that it can be accommodated under the rearmost seat of the coach. The radiator has been removed to the front of the vehicle and the fan is driven by a propeller shaft running throughout the whole length of the chassis. The fan can be manually disconnected as the long water-pipes between radiator and engine ensure sufficient cooling at normal atmospheric temperature without the aid of the fan. The vehicle has a constant-mesh gearbox with individual dog clutches for each speed, which are operated by compressed air through a control lever on the steering column.

The Magirus bus equipped with the 175 h.p. air-cooled Deutz engine, shows how easily a short Vee engine, requiring no space for a radiator, can be accommodated at the rear with practically no loss of platform space and without unduly increasing the overhang. An interesting arrangement is the air duct, leading from the roof to the engine compartment.

Daimler-Benz approaches the problem of saving platform space by mounting the 145 h.p. six-cylinder engine with gearbox and radiator transversely behind the rear axle, an arrangement which, though making the power unit easily accessible, involves a somewhat complicated transmission line. In the Mercedes bus the torque is taken off the end of the six-speed gearbox by a bevel gear, which brings the transmission back at a sharp angle towards the centre of the chassis. A short propeller shaft with two universal joints leads from the bevel-gear casing to an intermediate bearing and a second propeller shaft takes the drive to a rear axle of standard pattern with a central differential casing. The whole assembly up to the intermediate bearing is mounted in rubber cushions on a sub-frame, which is bolted to the chassis and can be easily removed (Fig. 16).

The design of the coach bodies, as a rule a stressed-skin structure on a welded steel frame, is generally good, as are the interior decorations and the arrangements for heating and ventilation. Among examples of the chassisless body construction was the Ford forty-two seater rear-engined coach having integral construction with light-metal panelling, which, fitted with a 85 h.p. six-cylinder "Hercules" diesel engine, weighs only 4·5 tons.

The Frankfurt Show has illustrated in what manner the German motor manufacturers are aiming to reach their pre-war activity. The German industry of to-day has the will and the productive capacity to increase its export trade and great efforts are being made to regain pre-war markets and to establish new ones. How far these efforts will be successful will depend to a very large extent on the development of the international situation.

R.M.S. "Oronsay"

No. II—(*Continued from page 691, May 25th*)

PROPELLING MACHINERY

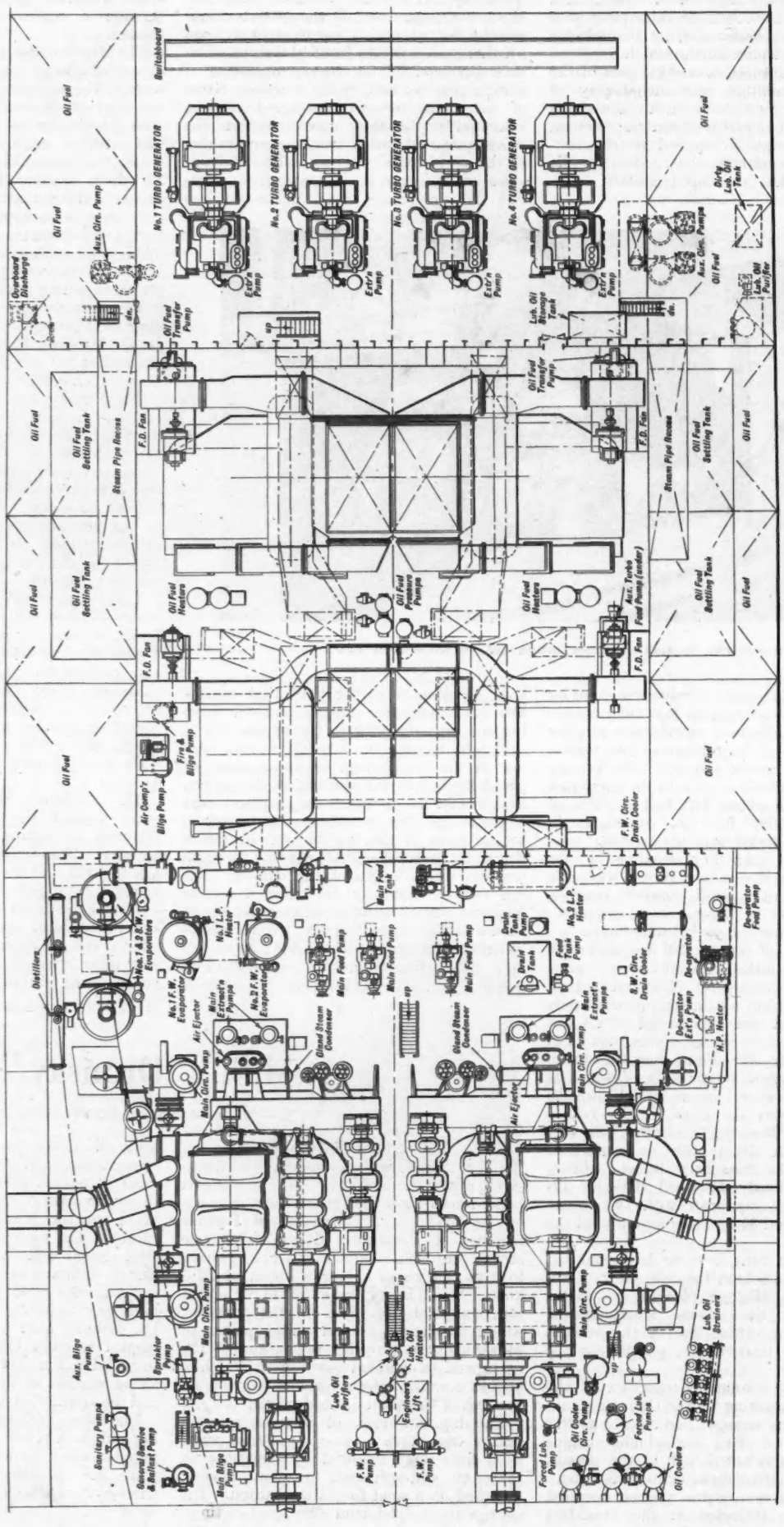
THE accompanying photographs and drawing giving the plan view of the engine and boiler-rooms show the general arrangement of the machinery. Two sets of Parsons turbines of Pametrada design drive two screws through double-reduction gearing to give the vessel a service speed of 22·5 knots. Steam is supplied at 500 lb per square inch and 850 deg. Fah. to the turbines, which develop a normal ahead power of 34,000 s.h.p. at propeller revolutions of 130 r.p.m. and an overload power of 42,500 s.h.p. at 140 r.p.m. Astern turbines develop 65 per cent of the normal ahead power.

The h.p. turbines, of impulse reaction design, each have a two-row impulse wheel as a first stage, followed by twenty-seven rows of end-tightened reaction blading mounted on a solid forged steel drum. The casings are molybdenum alloy steel castings, to take the high initial steam temperature, while the nozzle plates are of forged steel construction with vanes of "Macloy" steel securely pinned into the rings. There are thirty-five rows of end-tightened segmentally fitted reaction blading in each of the i.p. turbines, the rotors being of hollow forged steel design and the casings of cast steel. Thrust dummies are fitted to both h.p. and i.p. turbines, and Michell thrust bearings take any unbalanced thrust. Double-flow l.p. turbines each have eleven rows of segmental reaction blading in each half, all mounted on a hollow forged steel drum. The ahead portion of the casing is of cast iron and the astern of cast steel.

The astern turbines have all impulse blading and the h.p. astern turbine is a three-row impulse wheel shrunk on to each i.p. rotor, while the l.p. astern turbine consists of a three-row impulse wheel secured to the forward end of the l.p. ahead rotor. Nozzle plates are of cast steel and have vanes of

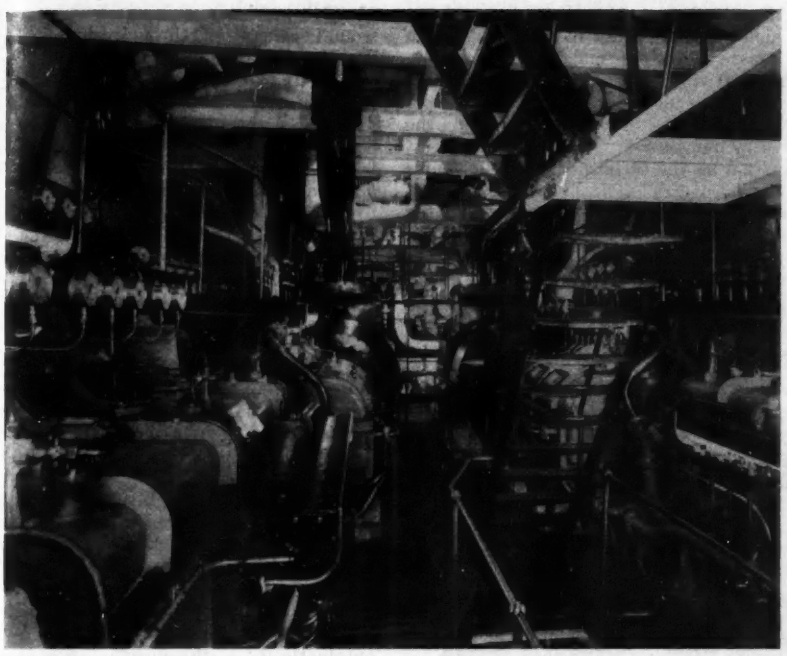
PLAN OF MACHINERY ROOMS, R.M.S. "ORONSAY"

VICKERS-ARMSTRONGS LTD., BUILDERS



"Macloy" steel. All the impulse blading is of "Macloy" steel and all the reaction blading of Monel metal.

Aspinal cut-out governors are fitted on all turbines, and, in the event of an undue drop in the lubricating oil pressure, steam is automatically shut off. Another safeguard is an electrically operated device, fitted to



MAIN TURBINES

the adjusting blocks, which gives warning should the pads wear down more than a set amount. Steam glands are fitted to each turbine casing, the inner pockets being connected to receivers and the outer pockets to two gland steam condensers, each maintaining a vacuum sufficient to ensure evacuating the most distant gland pocket.

Gearing

Each turbine is connected to the gearing by a flexible claw coupling. Double-reduction gearing, consisting of an independent primary set driving a secondary pinion engaging with the main wheel, is fitted to the h.p. ahead turbines while single-reduction gearing is employed for the i.p. and l.p. ahead turbines. The primary gearing for each h.p. turbine is housed in a cast iron gear case bolted to the main gear case, and consists of nickel steel pinions 13·71in pitch circle diameter by 31in face width and forged steel wheels of 34·49in pitch circle diameter with a 3in gap. The h.p. secondary pinions have a pitch circle diameter of 17·02in and the i.p. and l.p. pinions have a 12·62in pitch circle diameter, all being of nickel steel and fitted with central bearings and enclosed in a cast iron gear case. The main gear wheels having a pitch circle diameter of 174·09in by 49in face width, are cast iron with forged steel rims shrunk on. The bearing bushes are independent castings and are arranged so that they can be removed without lifting the main gear case covers.

With the h.p. turbines running at 3600 r.p.m. and the i.p. and l.p. turbines at 1931 r.p.m., the gear ratios are such that the propellers turn at 140 r.p.m. and the power developed is 42,500 s.h.p. All shafting is of solid forged steel, the diameters of the intermediate and propeller shafting being 21⅞in and 23⅝in respectively. Michell self-lubricating thrust blocks and tunnel bearing blocks are fitted, and the two four-bladed manganese bronze propellers by J. Stone and Co., Ltd., each have a diameter of 19ft, a mean pitch of 19ft 3in, a developed blade surface of 165 square feet, and weigh approximately 24 tons.

Lubrication of the turbines and gearing is effected by three electrically driven "Vertoil" oil pumps, with a magnetic filter fitted to the suction side. Each pump delivers 25,000 gallons per hour, against a discharge pressure of 55 lb per square inch, through "Lolos" filters and Serck coolers to gravity tanks of a capacity sufficient to ensure a seven-minute supply in the event of pump failure. Two steam-heated, electrically driven oil purifiers are supplied each having a capacity of 350 gallons per hour.

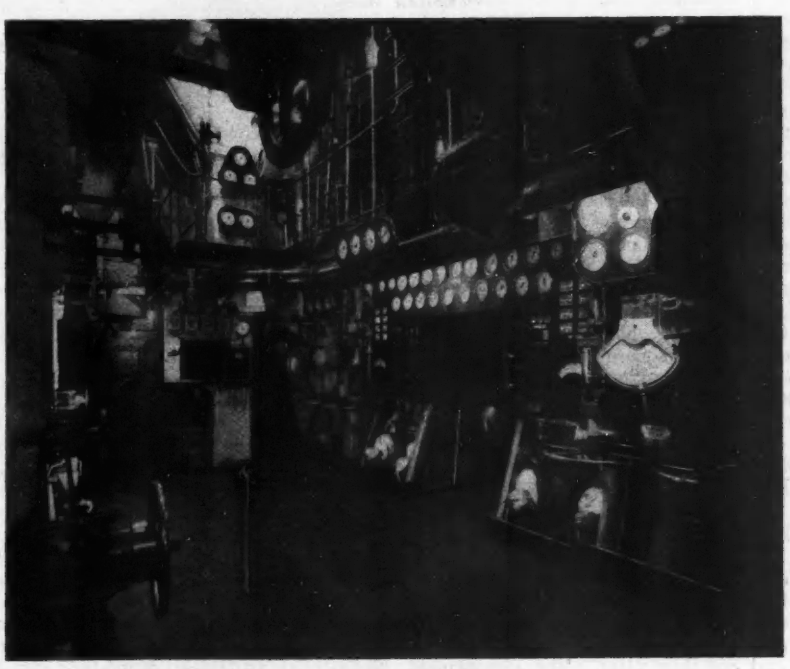
Steam Plant

Steam is supplied at a pressure of 525 lb per square inch at the superheater by two large and two small Foster Wheeler oil-burning water-tube boilers, giving a superheat control from 850 deg. Fah. down to 600 deg. Fah., when manœuvring. The boilers have seamless hollow forged steel drum shells with closed ends, and are fitted with Green's cast iron gilled economisers arranged for a feed water inlet temperature of 280 deg. Fah. and an outlet temperature of 400 deg. Fah. The large boilers each have a generating and water wall surface of 12,780 square feet, an economiser surface of 11,400 square feet and a superheater surface of 2515 square feet, the corresponding figures for each small boiler being 7805, 7800 and 1960 square feet respectively.

Burning oil fuel only under Howden's balanced system of forced draught, the large boilers have two electrically driven forced draught fans, with 101 h.p. motors, each delivering 54,000 cubic feet per minute against a pressure of 6·9in water gauge, and two induced draught fans with 173 h.p. motors, each dealing with 75,000 cubic feet per minute against a pressure drop of 7·75in water gauge. For the small boilers the rating for each forced draught fan, driven by a 46 h.p. motor, is 28,000 cubic feet against a pressure of 6·3in water gauge, and for each induced draught fan, driven by a 70 h.p. motor, 38,000 cubic feet against a pressure drop of 6·3in water gauge.

Vertical tubular air preheaters, providing a heating surface of 11,850 square feet for each large boiler and 6000 square feet for each small boiler, are fitted in the uptakes, and there are by-pass arrangements for slow steaming or when in harbour. Clyde steam-driven soot blowers are fitted to boilers and air heaters, and CO_2 recorders are supplied. The piping flanges, nuts and bolts used in the main steam system are of molybdenum-alloy steel, the pipe flanges being welded.

Wallsend oil fuel burning equipment is installed and consists of two heating and pumping units, the electrically driven pumps

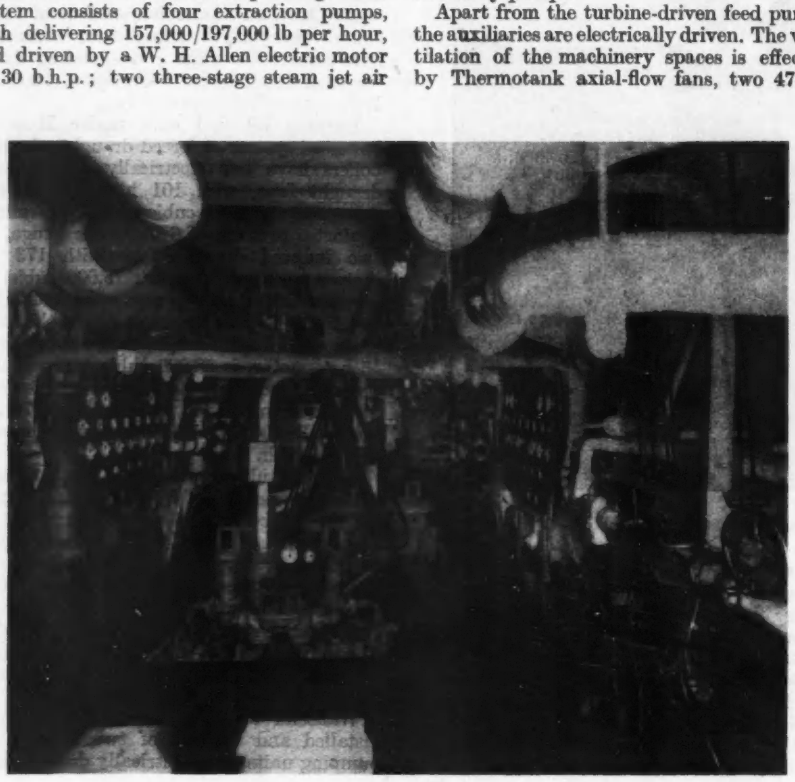


CONTROL PLATFORM

being by Stothert and Pitt Ltd. Low-level alarms and Weir externally operated oil fuel shut-off gear are fitted to all boiler steam drums. Alfloc chemical testing equipment is provided with an Alfloc injection plant for the treatment of boiler-feed water.

Closed Feed System

The main condensers, of Weir "Regenerative" pattern, have a total cooling surface of 35,000 square feet and can maintain a vacuum of 28in with sea water at a temperature of 86 deg. Fah. The condenser bodies are of mild steel and the tubes, of aluminium-brass, have a wall thickness of No. 18 gauge, an external diameter of ¾in, and are packed with Crane flexible metallic packing. The system consists of four extraction pumps, each delivering 157,000/197,000 lb per hour, and driven by a W. H. Allen electric motor of 30 b.h.p.; two three-stage steam jet air ejectors; one drain cooler with a surface area of 750 square feet; two closed feed control valves, one 6in and one 4in, and two steam condensers with a total surface of 210 square feet. Three main turbine driven feed pumps, each having a normal capacity of 350,000 lb per hour, and an overload output of 400,000 lb per hour against a discharge pressure of 725 lb per square inch, return the condensate to the boilers. There is a turbo-feed pump of 60,000 lb normal and 78,000 lb per hour overload capacity for harbour duties. A de-aerator of 60,000 lb per hour capacity with a vapouriser of 28 square feet is provided, and also a de-aerator extraction pump handling 60,000 lb per hour or 90,000 lb per hour on overload against a head of 50ft, and a de-aerator supply pump rated to deliver 56,050 lb at normal loading or 90,000 lb per hour on overload against a 65ft head.



Boiler Room

Distilling Plant and Auxiliaries

To provide fresh water from sea water to meet the boiler and domestic demands, and so reduce the amount of fresh water carried, the ship is equipped with a Weir evaporating and distilling plant. The arrangement utilises a main feed heater as a distiller for the vapour from the sea-water evaporator, so that the heat expended in evaporation is recovered in the boiler-feed water. The plant consists of two sea-water evaporators, each having a heating surface of 550 square feet and producing in parallel 150 tons per day with bled steam; a vapour preheater having 170 square feet and a distilled water cooler of 140 square feet; two low-pressure feed heaters, one of 850 square feet surface, and the other having 1100 square feet surface; one high-pressure heater having a surface of 850 square feet; two make-up evaporators, each of 300 square feet and producing 7000 lb per hour with bled steam; two 50 tons per day distillers for harbour use, and the necessary pumps.

Apart from the turbine-driven feed pumps the auxiliaries are electrically driven. The ventilation of the machinery spaces is effected by Thermotank axial-flow fans, two 47½in, two 40in and two 25in single-stage fans supplying the engine-room, while two 30in fans act as exhausts. The dynamo flat is supplied by two 35in fans and the boiler-room requirements are met by four 60in axial-flow fans, each delivering 45,000 cubic feet per minute against a head of 1½in water gauge.

Two pumps, each of 220 tons per hour capacity against a head of 120ft, maintain the supply of sanitary water, and the variations in demand are met by fitting a special speed control governed by a pressure regulator. This arrangement makes an efficient system and dispenses with the customary gravity tanks. For sewage disposal and the discharge of waste water overboard, there are fitted three "Duoflow" units supplied by J. Stone and Co., Ltd. The ship's fresh water supply is controlled by the Drysdale "Pneupress" system, and the two fresh water pumps are regulated by pressure switches on the "Pneupress" tank. The refrigeration machinery supplied by J. and E. Hall, Ltd., consists of three horizontal twin-cylinder CO_2 compressors, each driven by an Allen motor of 150 h.p., three condensers of two-pass, multi-unit design, three closed top cylindrical, submerged, two-pass evaporators and associated brine pumps.

Electrical power for auxiliaries, heating, lighting and cooking is provided by four Allen self-contained turbo-generators, each normally rated at 850kW, 220V d.c., with a two hours' overload capacity of 1060kW, and installed together with the main switchboard on a flat forward of the boiler-room. The turbines, which take steam at 500 lb per square inch at 850 deg. Fah., and have a steam consumption of 11·82 lb per kilowatt-hour, drive compound wound generators through double helical gearing, the reduction being from 6000 to 600 r.p.m. Each turbine is mounted on its own self-contained surface condenser designed to give a vacuum of 28in (barometer 30in), when supplied with cooling water at 86 deg. Fah. An electrically driven condensate extraction pump is fitted adjacent to each condenser and three circulating water pumps serve the four sets. The generators are arranged to run in parallel. In addition to the main plant there are two Allen emergency diesel-driven generators, which are arranged to run in parallel and can supply power for sea emergency load or the harbour load when the boilers are shut down. The emergency dynamo room is forward on "D" deck, and each generator has an output of 100kW at 220V d.c., and is driven at 500 r.p.m. by a four-cylinder, four-stroke diesel engine.

The main switchboard, supplied by Whipp and Bourne, Ltd., handles an aggregate of 16,000A, is 55ft in length, and is electrically divided into two sections by a "Splitter" breaker. Each section consists of two dynamo control panels, and two metering panels, and a preference tripping system automatically disconnects non-essential circuits should persistent overload occur. The switchboard distributes supplies to seventeen auxiliary switchboards, is interconnected with the emergency switchboard, and electrical interlocks prevent the paralleling of the main dynamos with the emergency dynamos.

Fluorescent lighting is fitted extensively throughout the various public rooms and first-class cabins, and to supply the necessary power two motor-driven 50kVA, three-phase, 230V alternators, with exciters, are fitted to starboard at the aft end of the engine-room. The a.c. control and distribution switchboard is fitted adjacent to the alternators. The switchgear provides for single or parallel running, and is equipped with synchronising gear, frequency meter, triple-pole switch, and voltage carbon pile regulators.

At present the ship is not equipped with a stabiliser, but a compartment is reserved just forward of the boiler-room for the fitting of Denny-Brown ship stabiliser equipment at an early date. The gear will follow the lines of that supplied to the "Chusan," and will be powered by Allen motors, two of 50 h.p. and one of 15 h.p.

Books of Reference

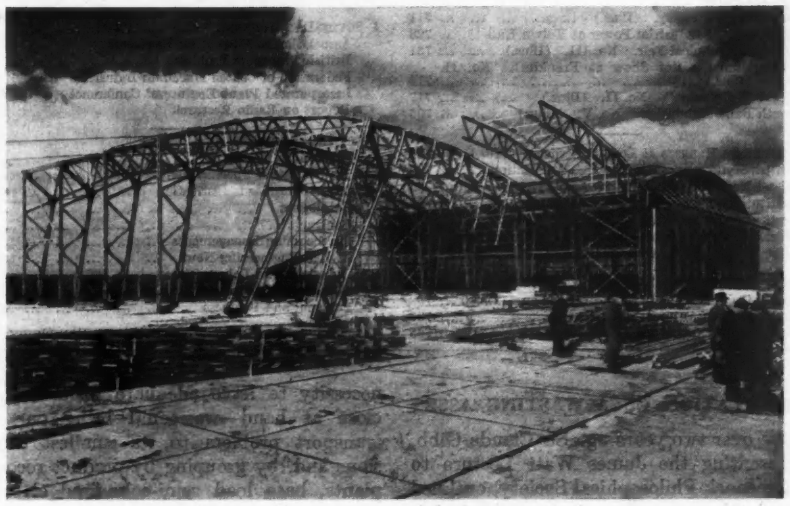
Water Engineer's Handbook, 1951. Compiled by the staff of *Water and Water Engineering*. London: The Colliery Guardian Company, Ltd., 30 and 31, Furnival Street, Holborn, E.C.4. Price 15s.—Users of this well-known volume will be familiar with the range of information presented, which remains as in previous years—first, a directory of water undertakings in the British Isles, followed by statistics of waterworks and the hardness of water, and details of water engineers and consultants, river boards, and so on. There is then information about the relevant Government departments, institutions and associations. Finally, a list of British Standards applicable to water engineering is given, together with technical information about various hydraulic formulæ.

Aluminium Hangars at London Airport

WE recently visited London Airport to see the aluminium alloy hangars which are under construction there, and which are claimed to be the first hangars to be built entirely of that material. The completed structure will consist of three similar bays, each of 125ft clear span and 110ft long, with a clear door height of 30ft. The overall span of each bay is 150ft. As may be observed from the accompanying illustrations, the structure of each bay consists of six two-pinned braced portal frames at 22ft centres, with purlins spanning between them, the purlins also being braced to the full depth of the main frames. A horizontal wind girder is provided between the first and second portals, and there are various wind bracing members between each of the outside pairs of portal frames. The roof decking is of corrugated aluminium alloy covered with a layer of insulation board and bitumen felt. An insulation factor of 0·36 B.Th.U. per hour per degree Fahrenheit per square foot was specified for the cladding and the doors, the figure actually obtained with the roof construction being 0·33. The side walls and gables are of corrugated alloy and a fire-resisting insulation board, with an air space of 4in between the two components, giving an insulation factor of 0·27. The glazing gives a daylight factor of 18 with the doors closed. Gutters and downpipes were all made up from aluminium alloy.

Gusset and batten plates ...	HS.10.WP
Extruded sections	HE.10.WP
Castings	LM6M and LM4M
Sheeting	NS.3.3/4 hard, pretreated by the "Alochrome" process

The structure was designed for a superimposed load of 15 lb per square foot due to snow, and a wind load of 25 lb per square foot. A two-pinned portal was adopted to avoid complications in the design of the foundation blocks, which are of reinforced concrete. The hinges are at 145ft 6in centres and are each formed by a high-tensile steel pin passing through a base casting bolted to the foundation block, with a gusset casting forming the lower end of the portal leg. The portals themselves consist in the main of double channel sections, battened together 6½in apart with internal members fitted between with gusset plates. There are vertical expansion joints in the side cladding, gable cladding, and over the roof in the decking and glazing. The accompanying table gives the British Standard references of the alloys used for the various parts of the hangar.

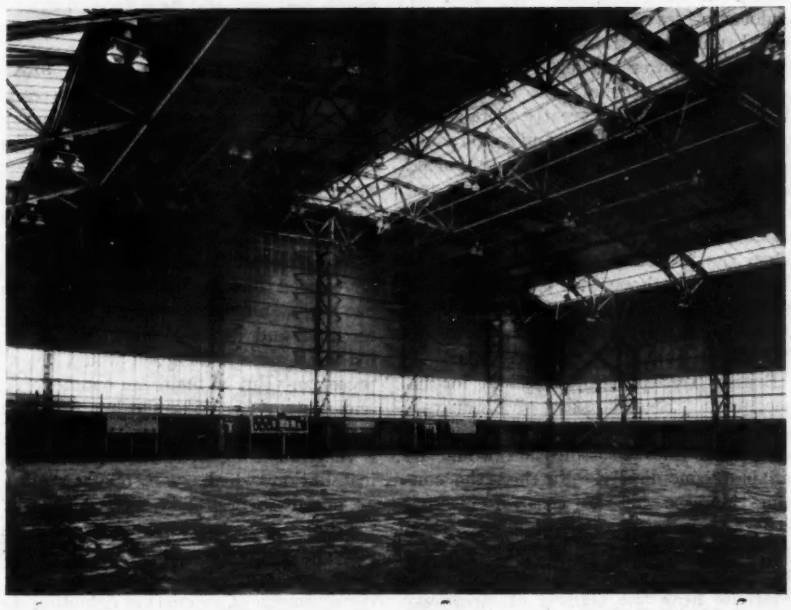


ERECTION OF HALF PORTALS OF SECOND BAY

Erection

Each half portal was delivered to the site in four parts, which were fitted together with turned bolts. The half portals were erected in pairs, with the purlins and rafter bracing in position. They were hoisted into position with two winches situated about 150ft behind the pins, one on the axis of each frame. The hoisting is shown in progress in our second illustration; the mid-span end of the pair of half portals is raised from ground level to its final position by rotation about the pins. On erection of the second pair of half portals the centre joints are made with turned bolts. The total weight of the half portal assembly is about 3 tons. In the case of the centre portals, which had no cross bracing between them, a set of bracing was fixed temporarily for erection. It was found that the erection of a unit of four half frames could be carried out in five days by six men with the help of two extra men on the winches during the lifting operation.

It is said that this aluminium alloy hangar design is competitive in cost with one in steel, the advantages of aluminium construction including ease of erection and freedom from painting or other maintenance against corrosion. The hangar was designed and built by Structural and Mechanical Development Engineers, Ltd., of Slough, Bucks.



INTERIOR OF COMPLETED HANGAR

Machine Tools and the Rearmament Programme

THE third report of the House of Commons Select Committee on Estimates for the session 1950–51, which was published on Tuesday last, deals with estimates submitted by various Government departments in relation to expenditure on the rearmament programme. It says that the evidence taken by the committee made it clear that the incidence of expenditure on equipment under that programme would be on a rising scale until 1953–54. Expenditure on much of the equipment is dependent on the installation of machine tools and the creation of new lines of production, many of which cannot be ready for eighteen months. The section of the report which deals specifically with the supply and use of machine tools contains the comment that, while there are now more machine tools than ever in the United Kingdom, they are not used to the best advantage because of the absence of multi-shift working. Their present use, in single shifts only, results in a great amount of idle time. Wartime direction of labour, the report says, made adequate numbers of workers available and so permitted something like the maximum use of tools by means of night shifts. The committee recommends that, short of the reintroduction of wartime conditions of labour, steps should be taken to investigate what can be done to remedy the existing serious situation. Furthermore, in the evidence submitted to the committee, it was emphasised that the abnormal demands of rearmament made it impossible for the machine tool industry to function with maximum efficiency, bearing in mind the diverse and conflicting claims which already exist for machine tools.

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FOUR ART PLATES—SOUTH BANK EXHIBITION

CONSERVATION OF A WASTING ASSET

JUST over two years ago Sir Claude Gibb, in presenting the James Watt Lecture to the Greenock Philosophical Society, outlined a plan for the more economical use of Britain's limited coal resources in order to preserve as long as possible the wasting asset they represent. In February last, in a lecture to the Yorkshire Branch of the Institute of Fuel, which we reprint in this issue, he returned to the charge. Much that he said in that second lecture amounted to no more than a restatement in less detail of propositions in the first. But because of the undoubted importance of the subject, we have thought it very well worth while to print this second lecture in full, repetitive though it is.

Much is now clearer than it was in 1949. In particular, it seems less likely now than it did then that the coal output of the mines can be increased as rapidly as the demand for coal in this country is rising. Even the Coal Board's fifteen year plan only assumes an output at the end of that period of 240 million tons per year, a target that may or may not be reached. Moreover, the law of diminishing returns applies markedly to coal mines; it is likely, therefore, that the cost of coal, relatively even if not absolutely, will grow. Already increased cost has led fuel users to seek economies in the use of coal. But, as Sir Claude points out, they "are endeavouring to utilise it more efficiently not in an endeavour to conserve our precious national asset but merely because coal has increased so much in purchase price." He suggests that better use could be made of our coal by its gasification, by its treatment to produce oils and other by-products, at present burned and sent out to pollute the atmosphere, and by burning the residues of coke and semi-coke in power stations. He suggests that "by siting coal processing plants reasonably adjacent to the geographical centres of the major coalfields—always having in mind the gas and electrical demands of the surrounding areas and the necessity to have adequate water supplies close at hand—we could bring our coal transport problem to its smallest dimensions and, by grouping by-product recovery plants, base load semi-coke-fired electrical power stations and low calorific value gas turbines to cope with peak loads, we could achieve national economies which would be startling." Nor is that all. Even in the use of the resulting electricity and gas the object should be to use that which is the more economical of the original coal. Sir Claude would have the use of the electric fire discouraged and, where district heating was inappropriate, gas used for the purpose; he would have the main line railways electrified to save the raw coal used by steam locomotives at low thermal efficiencies; he would run freight trains at night to equalise loads on power stations. All this he links with the power of coal by-products in the form of fertilisers greatly to raise the output of British agriculture and so to reduce this country's dependence upon imported food supplies. It is in fact a great and coherent scheme to regard coal as a very valuable mineral rather than as a raw fuel.

When the proposals were first ventilated we expressed the hope that specialists, each in their own fields, would pronounce upon them. Since then at least some evidence has come to light. The recent report by the British Transport Commission, for instance, upon "Electrification of Railways," has shown that upon some 45 per cent of British main lines electrification would be justifiable economically. Further, the continuing increase in the cost of internal transport is certainly making more attractive the transmission of power from the coalfields rather than the carrying of coals to stations near the centres of electricity demand. Undoubtedly the gas turbine would be in its element in generating power from coal gas and may also prove able to use gas from thin, unworkable seams gasified underground and from the uptake ventilating shafts of gassy mines. The practicability of coal distillation has long been proved even if its economics are more debatable. Moreover, Sir Claude is able to claim that "the processes available for coal distillation are capable of adjustment . . . and there would be no difficulty in arranging a balance between the products produced and market demand for the products." The practicability of the whole conception does not therefore seem to be in doubt. What is less certain is its economic effect. Could the valuable by-products of coal be produced as cheaply as they could be bought elsewhere in the world or made from imported materials? If not, would the reduced need for this country to import foods from abroad counterbalance the enhanced difficulty of exporting goods whose price might be increased? To make the scheme effective and to wean the public away from the use of raw coal in the domestic grate and the use of electricity for cooking and heating, would it be necessary to impose price controls or taxation in order to make gas seem cheaper for those purposes than coal or electricity—a policy possibly unpopular and therefore difficult for Party government to carry out? We ask these questions in no spirit of carping criticism. We ask them because they—and certain others—seem relevant, because the answers would be illuminating, and because such economic questions must arise and must influence decisions upon any great and imaginative policy. Sir Claude in pressing his point of view with his usual forcefulness is not, of course, criticising the scientific advisers of the Government. He is putting before them a new scheme that has been rendered practicable by the recent nationalisation of the coal, power and transport industries. We are glad to feel that it is certainly receiving study. For recently, as we noted in this journal, the Federation of British Industries has been conferring with the Ministry of Fuel and Power upon fuel usage and we are sure that Sir Claude's proposals were discussed.

DEFENCE OF SHIPS AT SEA

THE high speeds of modern aircraft and submerged submarines create serious problems for the defence of ships at sea. For the submarine the main advantage of fast underwater speed lies, at present, in the greatly improved chances it gives her of evading the anti-submarine escorting vessels after completing her attack. Her attack cannot be carried out at high speed because her battery at maximum output lasts less than an hour and because the "feather" made by the periscope at speed would betray her presence. But to maintain contact with her and destroy her after she has fired her torpedo, the anti-submarine vessel must have a very much higher speed and also an asdic installation which will operate efficiently at speeds over 18 knots, which was the maximum effective operating speed in the last war. Government naval spokesmen have announced in Parliament that the development of submarine detecting devices is fully keeping pace with developments in the submarine's powers to evade and attack, but one's faith in these assurances has recently been rudely shaken. Viscount Alexander, it will be remembered, assured the House of Lords that our anti-submarine forces are stronger and better able to deal with enemy submarines to-day than they

were in 1939. Yet the White Paper on the System of Command within the North Atlantic Treaty Organisation informs us that without the assistance of the United States Navy we cannot hope successfully to fight another Battle of the Atlantic!

But whatever the prospects of coping with the submarines of to-day, the submarine of the immediate future will present a far more serious problem. The true submarine—requiring no air and able to proceed at an anticipated speed of 25 knots for prolonged periods at depths down to 600ft—is no longer a vision of Jules Verne. Two of them are being built, or have been ordered by the United States Navy, one with engines using hydrogen peroxide and the other with an atomic energy plant. And the submarine's offensive power will be still further increased if, throughout her attack, she is able to take reliable bearings of the target and fire her torpedoes by asdic. For there will then be no need for her to come to periscope depth and her approach and attack can be carried out at high speed. Indeed, an asdic installation may well prove to be a double-edged weapon when the true submarine comes into service, for there seems no reason why the efficiency of the submarine's equipment should not improve correspondingly with the improvement in the surface vessel's installation. Finally, there is the development to be expected in atomic weapons, which will enable submarines, with the minimum of technical skill on the part of their commanders, to fire atomically charged guided "V2" rockets on our large towns. It is true, of course, that developments do not always favour the submarine. From United States semi-official sources it is learnt that the U.S. Navy is developing an anti-submarine rocket with good underwater ballistics. And our Parliamentary Secretary to the Admiralty informs us that a new type of asdic installation has been produced which is able to detect, locate, aim and fire at a submarine all in one equipment. These and other inventions will no doubt prove of the utmost value, but the first essential which has been repeatedly urged in this journal is to build as many fast anti-submarine vessels as we can possibly produce. We cannot have too many of them, irrespective of the number provided by the United States Navy, on which, it appears, we now have to rely.

Thanks to radar and the rocket, and ultimately the guided rocket (air-to-air and surface-to-air), there are good prospects of dealing effectively with bomber attack. Increased speed of attack means that aircraft have to be detected at a greater distance and their range and height estimated much earlier than hitherto, but these requirements are already being met to some extent by radar and the development of automatic medium calibre rapid-fire anti-aircraft guns with automatic fire control. Marked progress, too, is being made with the surface-to-air rocket and United States high-ranking officers have expressed their confidence that the anti-aircraft rockets now in advanced stages of development will be able to bring down aircraft even when above 60,000ft. Interceptor or fighter aircraft will also play an increasing part in the defence of ships at sea. United States naval interceptor aircraft are now equipped with a new air-to-air rocket with folding fins, which permit more compact stowage and allow a much larger number of rockets to be carried than hitherto. The new rocket has also a much greater range and speed and brings a bomber under fire at a range beyond the latter's defensive power. Automatic equipment assists the pilot travelling at 500 to 600 miles an hour to find, recognise and track his target. The guided missile, however, seems likely to be the anti-bomber weapon of the future, whether fired from ships or aircraft. It may be defined as a missile which can be directed to a target either by instruments outside the missile or by instruments built into it, and much research is being devoted to it in the United States. As sonic speeds are approached and surpassed by both bombers and fighters, aerial combat with conventional guns and rockets will become almost impossible. The high-speed fighter, flying at an altitude of 40,000ft or more, not only has a very short time to intercept an enemy bomber but may have little opportunity to make more than one approach to aim. The use of a guided missile, on the other hand, will almost replace the human element. A radar picture will indicate to the pilot the optimum time and direction to launch his missile, which will automatically be kept on the interception course.

Literature

N.P.L.: Jubilee Book of the National Physical Laboratory. By JOHN LANGDON DAVIES. London: H.M. Stationery Office, York House, Kingsway, W.C.2. Price 4s.

THIS book has been published to celebrate fifty years of service to the community rendered by the National Physical Laboratory—or the N.P.L., as it is more familiarly known. In fact the N.P.L. passed its fiftieth birthday on January 1, 1950, but celebration of the event was deferred at the instance of the Lord President of the Council to coincide with the Festival of Britain. The N.P.L. was the second of the great national research organisations to be founded, the first being the Physicalisch-Technische Reichsanstalt, which was instituted at Charlottenburg in 1880, with Hermann von Helmholtz as its first director and Werner von Siemens as one of its main industrial sponsors. Within twenty years, as the jubilee book points out, the benefits derived by German industry from its union with science as applied by the Physicalisch-Technische Reichsanstalt were becoming apparent: the dyestuffs industry and the Jena glass industry provided but two examples. In the meantime, in Britain, men like Sir Oliver Lodge had begun to press for the establishment of a "Physical Observatory precisely comparable to the Greenwich Observatory and aiming at the very highest quantitative work in all departments of physical science. . . ." However, Sir Oliver's idea was received with little enthusiasm and eight years went by, punctuated at decent intervals by the setting-up of committees, before the Government could be persuaded into action, to the extent of asking Parliament for grants of £4000 a year for five years and of £12,000 for the erection of suitable buildings. These rather modest sums provide an interesting contrast with the sums set aside for establishing the parallel institutions in Germany. For instance, the Reichsanstalt buildings and equipment cost £195,000 and the expenditure at the outset was £15,000 annually. Similarly, for the National Bureau of Standards, which was set up in the U.S.A. two years after the N.P.L., a sum of £115,000 was made available for buildings and the yearly expenditure was £19,000.

It says much for the enthusiasm of the N.P.L. staff, under the inspiration of their first director, Mr. (later Sir) Richard Glazebrook, that the laboratory was able to develop rapidly from a fledgling of the Kew Observatory into a separate entity with a growing programme of work on standards and research. Specific investigations in mechanics and engineering, electricity, metallurgy, optics, and thermometry, formed the pattern for the various divisions into which the work of the laboratory was grouped, from time to time, as the demands of industry required and as finances permitted. Financial difficulties were a constant handicap. For example, when the director visited Paris and Berlin to choose apparatus for work on the comparison of platinum and mercury thermometers from 0 deg. to 100 deg. Cent., it was Sir Andrew Noble who, as a private individual, met the cost of £1000. It is a matter of history that the tank for testing ship models, which was proposed by a committee of the Institution of Naval Architects in 1901, would not have come into being but for the generosity of another private benefactor, Sir Alfred Yarrow, who provided the necessary funds in 1908. Similarly it was a contribution of £5000 by Sir John Brunner, the engineer, that was mainly responsible for the equipment of the electrotechnics building (opened in 1906), where C. C. Paterson began work on photometric standards and general electric testing. Indeed, it is certain that Glazebrook and those who succeeded him as Director of the N.P.L., had to devote patient and persistent effort to the raising of funds, which were so important a factor in the services that the laboratory could render to industry. However, there is little doubt that the influence of the N.P.L. and its resources increased as the scope of its work grew and the years 1910–18 saw substantial developments. The metallurgy building was established with the financial help of Sir Julius Wernher and a new optics building was opened. This was the era when the activities of aeronautics and wireless telegraphy began to come within the purview of the N.P.L. By the end of the first world war the national importance of the laboratory was recognised by the transference of financial control to the Department of Scientific and Industrial Research, although the Royal Society, as the parent of the N.P.L., remained closely associated with its scientific administration. That war might be said to have marked the end of the critical and formative period in the history of the N.P.L. Thereafter, with its status assured, its development has proceeded on more or less tranquil lines under a succession of directors—Sir Joseph Petavel, who succeeded Sir Richard Glazebrook, and was, in turn, succeeded by Sir Frank Smith, and by others, whose names are now household words: Sir Lawrence Bragg, Sir Charles Darwin, and Dr. E. C. Bullard, the present director. Equally well-known is the N.P.L.'s more recent work on the maintenance of standards and the investigation of the possibilities of using the wavelengths of light as a linear standard. Its research activities, particularly short-term studies, are perhaps even more familiar, touching as they do upon the current practical needs of the engineer. They include an increasing variety of topics, such as the behaviour of

ships' propellers, aerodynamics and wind-tunnel testing, wind pressure on buildings and structures, lubrication and fluid flow, creep in metals and their resistance to high temperatures, the behaviour of dielectrics, and radar and its use in meteorology. Some of the newer branches of study suggest trends along which the N.P.L. may develop in the future. In aerodynamics and radio, short-term work on specific practical problems may tend to occupy the attention of other establishments, while the more fundamental research may remain with the N.P.L. On the other hand there are new fields to be explored in certain branches of electronics, as applied, for example, to computing engines, which suggest increasing scope for the activities of the N.P.L. in the second fifty years of its existence.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PRESENT-DAY LOCOMOTIVE WORKING IN GREAT BRITAIN

SIR,—Your correspondent, Mr. Semmens, in quoting coal consumption figures for Class "5" locomotives working between St. Pancras and Manchester, does not mention certain reservations made by Mr. D. R. Carling, when he gave these figures in his paper "Locomotive Testing on British Railways." It was not stated in the paper that this saving of 5 cwt of coal was definitely possible in this case, the circumstances of the two runs being different.

In particular, the speed restrictions observed on the actual run appear to be more severe and more frequent than those considered for the calculated performance. Estimates of the difference in coal and water consumption due to such checks may vary widely, the actual difference being very much dependent on the method of driving adopted. However, taking as a basis the table given by Lt.-Col. Rudgard, in his Presidential Address to the Institution of Locomotive Engineers, figures of 600 lb of coal and 450 gallons of water appear to be a reasonable estimate of the extra consumption on the actual run, as compared with the calculated maximum efficiency run. Deducting these amounts gives the following figures:—

	Maximum performance	Maximum efficiency	Actual run (adjusted)
Total coal (lb)	7387	6729	6700
Total water (galls.)	5508	5264	5050
Time	3 h 37½ min	4 h	4 h 22 min

This would seem to indicate that under similar conditions a speed slightly lower than that for maximum efficiency at the drawbar would result in a reduction in steam consumption and, given equal boiler efficiencies, a corresponding reduction in coal consumption. It should also be remembered that without the additional checks the time for the actual run would probably have been about 4¼ hours.

In addition, it would be most unwise to assume that all engines of this class, on their many and varied duties, could be rescheduled to produce any coal economy. The amount of coal used can be only one of many considerations, the requirements of the public and efficient utilisation of track, train and engine being of equal if not greater importance.

M. G. SMITH

Bath, May 18th.

The National Physical Laboratory

THE annual series of open days of the National Physical Laboratory at Teddington were held from May 23rd to 29th. The open days provide an opportunity for visitors to see something of the broad scope of the work of the Laboratory, but the notes below will be confined to one or two specific subjects upon which work is at present in progress, since the general aims and achievements of the Laboratory are indicated on page 723 of this issue, in the review of the anniversary volume which has recently been published.

Fatigue Testing Machines.—A multiple-unit direct-stress fatigue testing machine has been developed by the Laboratory, in which it is possible to test twenty-four pieces at the same time. The test pieces are disposed round a circle with their axes vertical and their upper ends secured in a fixed head integral with the frame of the machine. At its lower end each test piece is secured to a loading rod, which is constrained to move only vertically by flexible strips. The loading heads are prolonged downwards and pass through clearance holes in a swash plate which is carried on a gimbal mounting at the axis of the machine. A nut on the outer end of each loading head secures a spring which bears at its upper end on the underside of the swash plate. By a central screw adjustment the centre of the swash plate may be raised or lowered relative to the frame of the machine. As the swash plate is pushed downwards it comes in contact with a runner rotating about the axis of the machine in a fixed horizontal plane; the plate is thereby tilted and the line of greatest slope rotates at the speed of operation, which is about 2900 r.p.m. Each test piece is thus subjected to a pulsating load, of which the amplitude is determined by the product of the tilt of the swash plate and the stiffness of the stressing spring. By using springs of different stiffnesses a variety of load ranges can be obtained at any one setting of the swash plate control. When a test piece breaks the loading head in falling closes an electrical contact, which stops the corresponding counter. Thus the machine will run on until all the pieces have been broken, and equally, it may be operated with any number of pieces. The machine was designed and constructed for tests on small screws and it provides load ranges up to 50 lb.

The Severn Suspension Bridge.—The wind tunnel tests of the proposed Severn suspension bridge have already been described in this journal,* but progress has been made with the work since our last article, and it may also be interesting to compare the results with the design for the reconstructed Tacoma Narrows bridge.† The tests have been carried out with two aims: to investigate aerodynamic stability and to assess the static forces due to wind load. Tests on a full-length model of the bridge indicated that the most unfavourable conditions were obtained with the wind perpendicular to it, so that it was possible to carry out subsequent tests with "sectional" models representing a sample length of the bridge. Four sectional models, each 1/100th scale, incorporating successive improvements, have been tested. The first had an open central reservation, the width between the open braced stiffening trusses being 107ft (full scale) and the deck being placed midway between the top and bottom chords of the trusses. The presence of this gap much improved stability, and in the second model further improvement was obtained by splitting the roadway into four, with a central gap between each carriageway and gaps between the carriageways and a combined cycle track and footpath on each side. The width between stiffening trusses was 120ft, however, and to give structural economy the two cycle track and footpath strips were cantilevered outside the trusses in the third model, giving a width of 80ft instead of 120ft, and giving a further improvement in stability. In the last model the level of the decking was raised from mid-deck to top-deck, so that increased torsional strength could be incorporated by using two planes of cross bracing between the trusses. Having evolved the most satisfactory arrangement, the tests were then verified on a 1/32nd scale sectional model, which was substantially the same as the last 1/100th scale arrangement, the distance between the trusses being 78ft. This model has been tested in wind speeds (full scale) up to 250 m.p.h. and no instability has been found. For measurement of the static forces for stress calculation a similar 1/32nd scale model has also been employed.

Performance of Small Gears.—On certain types of precision mechanisms such as predictors, range finders and dial indicators, it is essential that the gear drive should operate smoothly and transmit constant angular velocity. The combined effect of the individual errors in the gear tooth elements is being investigated by means of a single-flank meshing machine, which records autographically the variations from uniform transmission of two gears when operating in normal running conditions. This is achieved by comparing the motion of the gears with that of two friction discs which rotate together without slip; the relative change in angular velocity between these two drives is a measure of the error in gear transmission. Work so far carried out relates to the overall performance of involute spur gears produced by different generating processes. The effect of small errors in tooth spacing, profile and surface finish arising from each method of manufacture can be demonstrated readily by the chart recording mechanism.

Two Million Volt X-Ray Generator.—A two million volt Van de Graaff X-ray generator has been installed in the new X-ray laboratory of the Physics Division. It is of compact design, in which the X-ray tube, together with the high-potential generating device, is enclosed in a pressure vessel at about 20 atmospheres, thus reducing the spark-over distance at two million volts to manageable proportions. At full power the X-ray output is roughly equivalent to the gamma-ray emission from 10 lb of radium. The Laboratory maintains the standard of X-ray intensity on which the doses administered in hospitals in X-ray therapy, and the measurement of the hazards to workers from high-energy radiation, ultimately depend. As the use of high energies becomes more widespread, so the difficulties of precise measurement increase, and the purpose of this installation is to allow the many problems of scattering, absorption and measurement of X-rays at high energies to be investigated more fully.

Testing of Precision Lead Screws.—Autographic testing of precision lead screws is carried out in the Laboratory's standard lead-screw lathe, on which the screw is mounted so that it is supported and driven between centres, the feed of the lathe saddle being set to correspond with the nominal pitch of the screw. A small stylus wheel mounted on the lathe saddle engages with the thread of the screw, and as this wheel is free to move in a direction parallel to the axis of the screw, errors in the helix of this screw will be revealed by the axial displacements of the wheel. These displacements are detected by an electromagnetic measuring head and after electronic amplification are recorded at a magnification of 1000. In this manner a continuous autographic record of the errors of the screw is obtained along its complete length. The method has the additional advantage that the test can be performed quickly.

* THE ENGINEER, Oct. 29, 1948, page 449

† THE ENGINEER, March 2nd, 1951, page 296.

BOOKS RECEIVED

Industrial Gas Turbines. By E. C. Roberson. London: Temple Press, Ltd., Bowling Green Lane, E.C.1. Price 8s. 6d.

Climate in Everyday Life. By C. E. P. Brooks. London: Ernest Benn, Ltd., Bouverie House, Fleet Street, E.C.4. Price 21s.

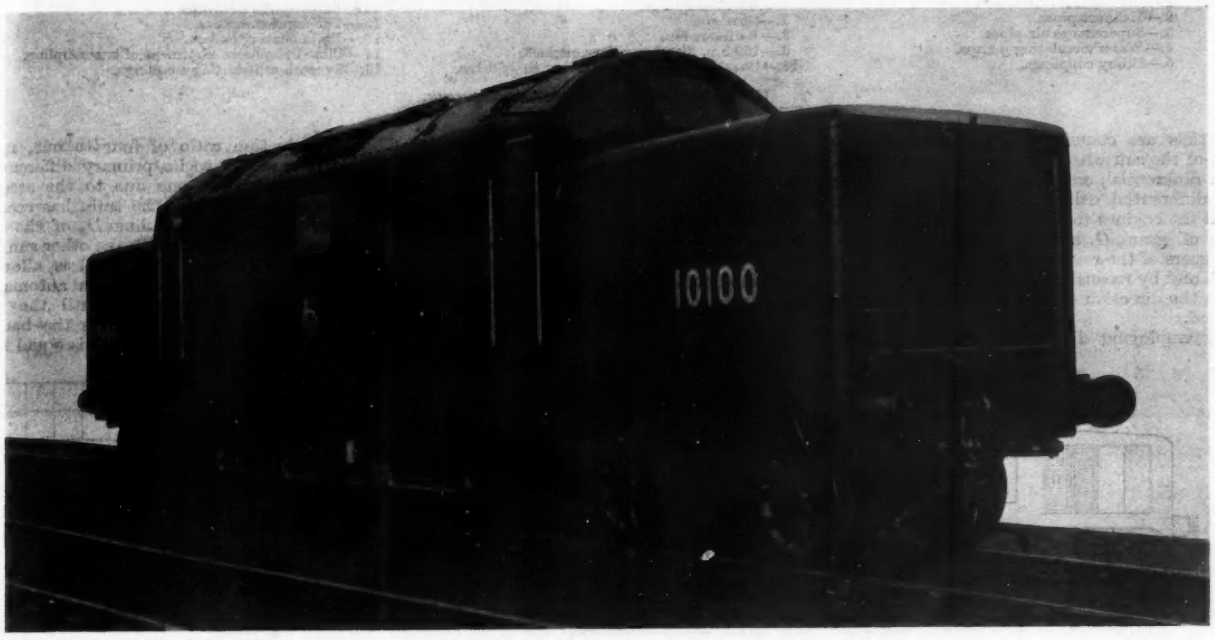
Physics in Chemical Industry. By R. C. L. Bosworth. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 70s.

Theory of Modern Steel Structures. By Linton E. Grinter. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 48s.

Diesel-Mechanical Locomotive No. 10,100

EXTENSIVE trials have been in progress on British Railways during the past few years with diesel locomotives for passenger, freight and shunting duties, and in addition to three main line units, there are at present more than a hundred diesel shunting engines in operation. Since each of these locomotives is powered by a single oil engine, and most of them have electric transmission, it was decided to build a new diesel main line locomotive incorporating the "Fell" system of mechanical transmission. The design of this locomotive, which was recently completed at the Derby works, has been based upon an entirely new principle in diesel power application and transmission proposed by Lieut.-Col. Fell and jointly developed by Mr. H. G. Ivatt, chief mechanical engineer of the L.M.R., and Fell Developments, Ltd.

The lay-out of the new locomotive and some of its major components can be seen in the photographs and drawings we reproduce. It has eight coupled driving wheels and a four-wheeled bogie at each end, with all the driving controls duplicated in a cab at each end, as in the main line diesel locomotives already in service on British Railways. Trials are being arranged to test it fully on work similar to that carried out by main line diesel-electric locomotives and to determine its suitability for the main line duties worked by comparable steam engines.



DIESEL-MECHANICAL LOCOMOTIVE No. 10,100

The "Fell" Transmission System

Before dealing with the constructional features of the locomotive an outline of the "Fell" multi-engined mechanical transmission system should be given. This system is designed to facilitate the grouping together of the power outputs of a number of engines having the required torque characteristics, and it is considered to have certain advantages over the use of a single main engine. With multiple engines, it is pointed out, a locomotive has increased dependability as it can continue to haul a train even if all but one of the main engines are out of action. The main engines used can be of a light, compact, high-speed design, which can be easily handled for replacement or repairs.

As the transmission employed is purely mechanical without the use of either electrical or hydraulic torque conversion, it is an essential feature of this system of locomotive construction that the main propelling engines shall, for the purpose of starting the train and for ascending steep grades, be capable of developing very high torques at low rotational speeds. To make this possible the engines are relatively highly supercharged at their lowest speeds and progressively less highly supercharged as their speed rises. It is therefore necessary that the engines employed shall have a good response to supercharging in order to economise air, and be of a type in which high supercharging at low speeds does not give rise to unduly high cylinder pressures.

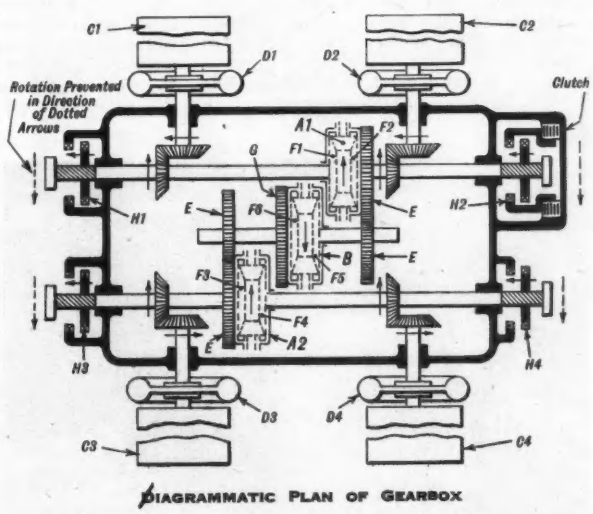
In order that the required supercharge, involving the supply of large volumes of air, may be available when the main engines themselves are running at low speeds, the air blowers of the displacement type are separately driven by auxiliary engines—preferably diesels, which are themselves supercharged off the same air supply in order to reduce their size and weight.

These auxiliary engines are provided with variable speed governors, which are in turn influenced by the supercharge pressure, so that a fall in this pressure automatically causes the auxiliary engines to speed up in an endeavour to maintain it.

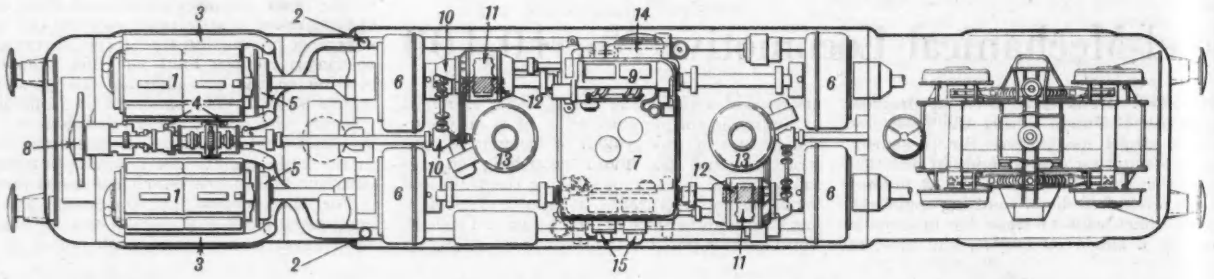
The capacity of the blowers, however, and the maximum speed to which these engines are permitted to run, are such that very early in the speed range of the main propelling engines the supercharge pressure commences to fall and continues to fall progressively as the speed of the main engines increases, so that at the highest speed of the main engines the supercharge is practically zero. The governors on the main engines limit the fuel supplied in relation to the available air charge and the engine speed. The decrease in supercharge pressure with speed, taken in conjunction with the limitation of fuel by the governor, results in the main engines developing approximately constant horsepower over their speed range.

For the purpose of connecting and disconnecting individual engines and the common mechanical transmission, each engine is provided with a scoop-controlled variable filling hydraulic coupling.

The common mechanical transmission system which has been adopted for the new locomotive involves the use of differential gears as a means of grouping together the output of four engines, as shown in the diagram we reproduce below. Three differential gears are so arranged that two, A_1 and A_2 act as primary differentials and the third, B, as a secondary differential. Each engine, C_1, C_2, C_3 and C_4, is connected through its hydraulic coupling, D_1, D_2, D_3 and D_4, to one of the four sun wheels of the primary differentials. The planet carriers of the two primary dif-



DIAGRAMMATIC PLAN OF GEARBOX



1.—500 h.p. diesel engines.
2.—Exhaust pipes.
3.—Supercharge air pipes.
4.—Water circulating pumps.
5.—Bibby couplings.
6.—Fluid couplings.
7.—Gearbox.
8.—Radiator fan.
9.—150 h.p. diesel auxiliary engines.
10.—Bevel gearboxes for auxiliary shaft drive.
11.—Supercharge blowers.
12.—Vacuum exhausters.
13.—Train heating boilers.
14.—Clutch to release abutment of one coupling.
15.—Synchro self-shifting couplings.

UNIT ARRANGEMENT OF LOCOMOTIVE

ferentials are connected by gears E one to each of the sun wheels F_6 and F_8 of the secondary differential, and the planet carrier of this last differential delivers the combined power of all the engines to the road wheels through a train of gears, G, and a final reduction drive. The gears of the reversing train are in constant mesh and by means of a special clutch arrangement the direction of locomotive travel can be altered.

By employing differentials in this manner a progressively changing speed ratio is provided without the use of change speed gears involving a series of stepped ratios. Furthermore, inherent coupling slip is minimised.

This feature will be apparent on considering the sequence of operations which take place when starting up the train and progressively bringing all four engines into action to propel it.

Assuming all four engines to be running idle with their hydraulic couplings empty, then on opening the regulator and at the same time allowing one of the couplings, say D_1, to fill, the associated engine, C_1 will commence to drive the sun wheel, F_1, to which the output side of that coupling is connected. It should be pointed out here that each of the four primary sun wheels, F_1, F_2, F_3 and F_4 has associated with it a uni-directional device H, which prevents any backward rotation of that particular sun wheel. It will be appreciated that as a result of driving one of the sun wheels, say, F_1, in a forward direction and of preventing backward rotation of the other sun wheel, F_2, of that primary differential, by means of the uni-directional device H_2, the planet carrier of that differential will drive the sun wheel, F_5 of the secondary differential, B, to which it is connected through the gears E, and so transmit the driving torque of the connected engine, C_1, to the road wheels via the gear G. This engine will thus be coupled to the final drive and road wheels with a superimposed gear reduction ratio of four to one, namely, two to one due to its primary differential A_1 and again two to one due to the secondary differential B. When the train has reached a suitable speed the coupling D_2 of the second engine, E_2, associated with the other sun wheel, F_2, of the primary differential is allowed to fill and this engine's output is automatically increased by its governor until the torque which it is developing exceeds the backward torque on its sun wheel, which is equal to that of the first engine engaged. As soon as this condition occurs, the sun wheel of this second engine moves in a forward direction and its rotational speed is added to the rotational speed of the sun wheel, F_1, which is already running. This results in an increased speed of the planet carrier of A_1 and so of the road wheels.

In a similar manner the remaining engines are in turn brought into action and it will be seen that the speed ratio between the engines and the road wheels, when the connected engines have attained the same rotational speed, will be four to one for the first engine, two to one for the second engine, one and one-third

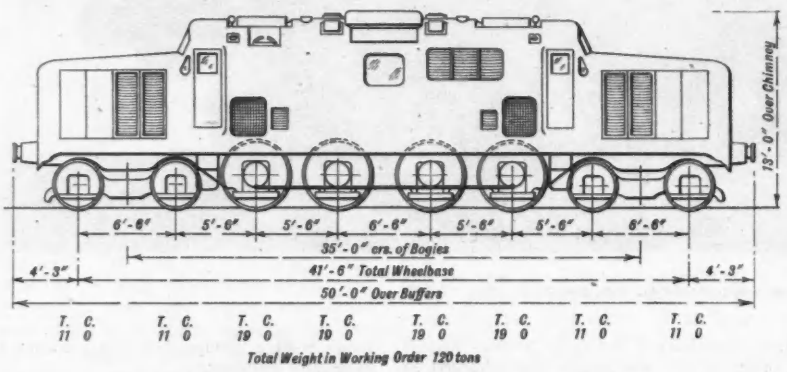
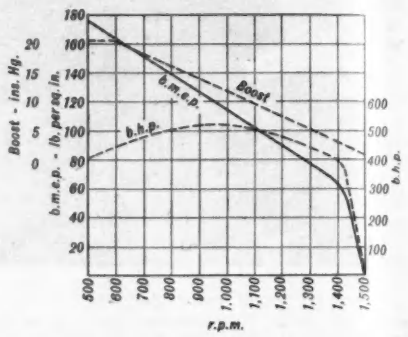
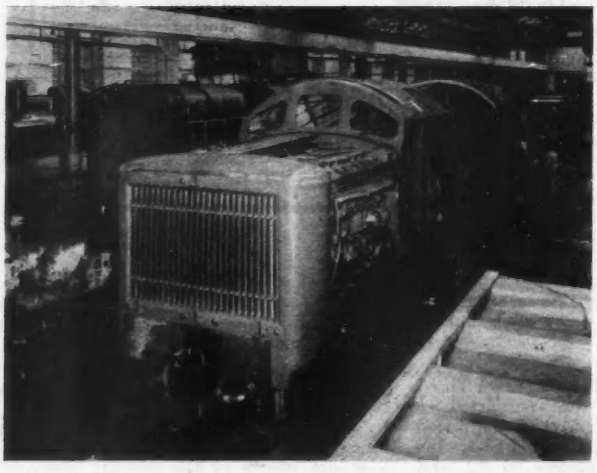


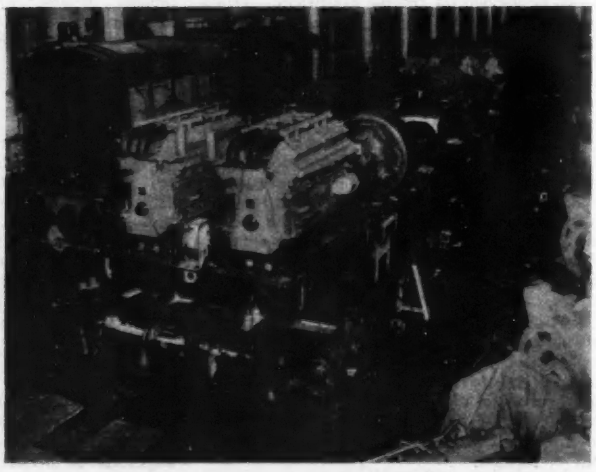
DIAGRAM OF THE DIESEL MECHANICAL LOCOMOTIVE



MAIN ENGINE PERFORMANCE CHARACTERISTICS



LOCOMOTIVE PARTLY ASSEMBLED



MAIN POWER UNITS BEING ASSEMBLED

to one for the third engine, and one to one for the fourth engine.

In the locomotive an "S.S.S." automatic clutch is fitted at the end of each of the primary sun wheel shafts to prevent reverse rotation. With this sun wheel shaft arrangement any attempt to push the locomotive backwards, would result in all the clutches becoming operative. To prevent this, one of the units, H_2, has its stationary member coupled to the gearbox structure through a suitable clutch, which can be released to free the transmission. This clutch is held "in" by a vacuum cylinder so that the transmission is free with no vacuum.

A feature of this mechanical transmission is that the changing speed ratios are passed through without shock by finger operation of triggers in the driver's cab, which are used to fill the hydraulic couplings in turn, with the regulator held in the maximum power position until all four engines are on load and running at the same speed. After this condition has been reached the regulator is manipulated as required to give the desired train speed with all four engines in operation.

It is interesting to note that the maximum tractive effort can be developed when only a single engine is propelling the train and that bringing the remaining engines into action permits the train's speed to be increased. Consequently any route which is within the capacity of the locomotive when all the engines are available could be completed (at reduced speed) even if only one engine remained effective.

Locomotive No. 10,100

The leading particulars of the new engine, which has been numbered 10,100, are as follows :—

Type	4–8–4
Main diesel engines	Four Davey Paxman 12 R.P.H.
Continuous rating (supercharged)	500 h.p. per engine
Total continuous rating (supercharged)	2000 h.p.
Cylinders (twelve per engine)	7in bore by 7½in stroke
Maximum main engine speed	1,500 r.p.m.
Auxiliary supercharged engines	Two six-cylinder A.E.C. A210D
Driving wheel diameter	4ft 3in
Maximum locomotive speed ...	78 m.p.h.
Tractive effort at 12 m.p.h. ...	25,000 lb
Adhesion factor...	5·65
Total estimated weight in working order	120 tons
Engine fuel capacity (main tanks)	720 gallons
Carriage heating fuel and service tank	150 gallons
Carriage heating water tanks ...	500 gallons
Header water tanks	60 gallons
Brake, per cent of engine weight —vacuum	47·6 per cent

The plan that we reproduce on page 726 shows the disposition of the principal units on the locomotive and its main dimensions and weights are given in the diagram.

In order that the four Davey Paxman twelve-cylinder main engines should have their full torque available for traction the two 150 h.p. A.E.C. auxiliary engines are used to provide power for driving separate supercharging blowers as well as all auxiliaries, such as radiator fans, vacuum exhausters, &c.

By using separately driven blowers for supercharging the diesel engines can be made to provide a wide torque variation over their speed range of 500 r.p.m. to 1500 r.p.m., the blower capacity being sufficient to supply air to maintain the full rated power, resulting in an almost flat horsepower curve over the complete range of speeds. The auxiliary engines, which operate over a speed range of 1300 r.p.m. to 1800 r.p.m., are themselves supercharged from the same air system and to the same inlet pressure as the main engines. In the graph we reproduce showing the performance characteristics of one main engine it can be seen how the supercharge pressure, the brake mean pressure and the brake horsepower of an engine vary over the speed range.

In order to limit the power output at any given engine speed to the predetermined value for that speed, a device is provided which is in effect an adjustable limit stop on the fuel pump rack, and which is under the control of a centrifugal governor. For this purpose each main engine is provided with a centrifugal governor, which, through hydraulic servo-mechanism, controls the angular position of a cam. The cam, in turn, limits the power output to the characteristics shown in the graph. Movement of the driver's regulator controls the power output of the engines within these limits by operating a pendulum lever in each governor.

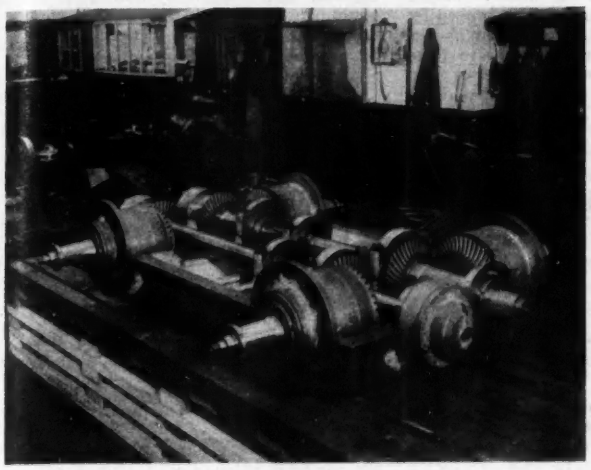
The pin on which the pendulum lever swings can be displaced by a vacuum-actuated diaphragm, in opposition to a spring, in such a manner that when it is displaced in one direction by the pull of the diaphragm, movements of the driving regulator can give the engine any quantity of fuel up to the maximum permitted by the cam. Release of vacuum allows the spring to move the pendulum lever suspension in the opposite direction so that the engine receives only idling fuel irrespective of any movements of the regulator.

The auxiliary engines are fitted with variable speed governors and a device controlled by the supercharge air pressure is directly connected to the governor speed lever so that when the air pressure falls the engine is speeded up and vice versa. Spring-loaded blow-off valves on the air trunking limit the supercharge to the desired value of 10 lb per square inch. In order to avoid unnecessary blower work when the locomotive is at rest with auxiliary engines and, consequently, the blowers running, these blow-off valves are so arranged that during such periods when supercharge is not required the air has a free escape to atmosphere. When supercharge is required, a vacuum is induced at a diaphragm, which causes the blow-off valves to operate as spring-loaded valves.

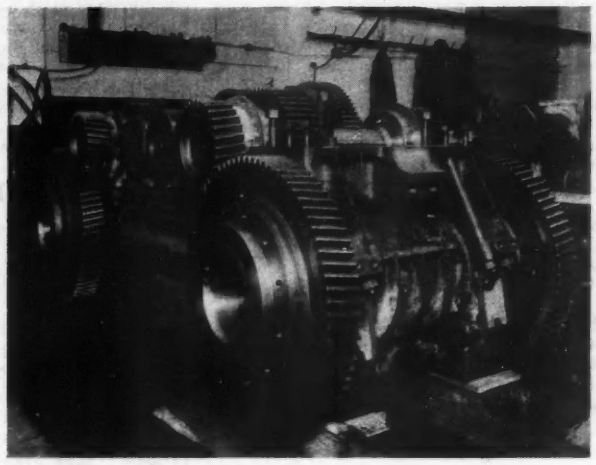
On the air trunking automatic valves opening inwards are also provided, so that the two main engines associated with that trunking can run as atmospherically aspirated units in the event of any failure of the pressure air supply.

The air delivered by the blowers passes directly into water-cooled after-coolers on its way to the engines. The water for these coolers is pumped through roof radiators and forms a circuit independent of the engine cooling system.

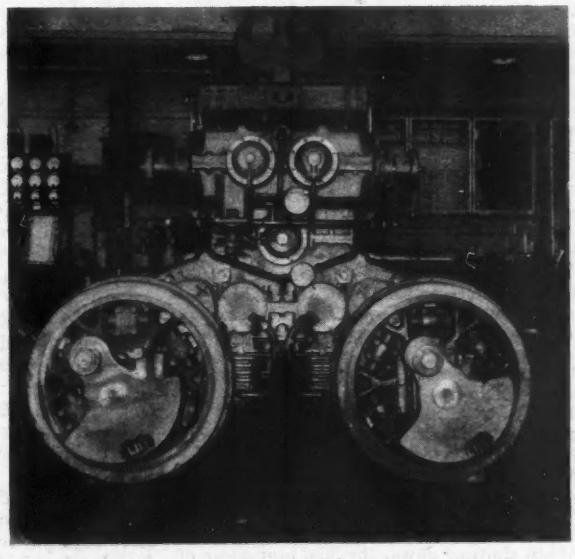
Each of the four main engines, which are arranged in pairs at the outer ends of the locomotive, drives the input side of a scoop-controlled variable-filling Vulcan-Sinclair, size 36, hydraulic coupling through a Wellman Bibby



Gearbox Top Assembly



Final Drive Wheel, Pinion, Cannon Bearing and Quill Shafts



Gearbox Mounted on Driving Wheels

coupling. These couplings, which are mounted on separate pedestal bearings on the main frame stretchers, are connected on their output sides through bevel gears to the differential drive shafts in the gearbox.

The lower section of the gearbox, which forms one of the principal features of the locomotive and the operation of which has already been described, contains the final drive train of gears and a reversing mechanism, consisting of a pair of sliding dog clutches. One clutch is engaged at a time according to the direction in which it is desired to run the locomotive and a warning light indicates that it is fully engaged.

From the reversing shafts the final drive is through two hollow quills, running in white metal bearings at each end of the bottom section of the gearbox and integral with it. The quills, to be seen in one of the illustrations, are mounted on the two intermediate driving axles with sufficient clearance above and below the axle to permit full freedom for rise and fall relative to the frames. At each end the quills carry arms, which transmit the drive to the wheels through flexible rubber units between the wheel spokes. Lubrication of the gearbox is by two external oil pumps driven by the auxiliary engines.

The outer and driving wheels are coupled together throughout by coupling rods with flexible pin joints, of the type universally used on the conventional eight coupled steam locomotive.

Locomotive Control Gear

Control of the locomotive is through vacuum diaphragm cylinders operated from reservoirs, which are connected to the vacuum brake system. Two exhausters driven by the auxiliary shafts maintain the vacuum in both brake and control gear reservoirs. This control applies to the main diesel governors, reversing gear, fluid coupling scoops, supercharging air control, "S.S.S." clutch release, &c.

The regulator handles are mechanically connected both with each other and with the speed controls on the main engine governors. In addition to the main regulator, four short starting levers, in front of the driver, each operate the governor and fluid coupling scoop vacuum cylinders. With the levers placed in the "stop" position the scoops are out and the diesel engines run free and the locomotive can over-run the engines.

When a lever is moved over to the "start" position, its fluid coupling is filled by its scoop through the operation of the vacuum cylinder, and its engine is put into positive connection with the gearbox. Each starting lever is operated progressively to engage engines to suit the speed of the locomotive.

The regulator control is so arranged that an engine continues to idle when the main regulator is open, if its fluid coupling is not engaged. For shunting work the driver can operate the locomotive at full torque on one engine only, cutting in the others as required when changing over from shunting to the main line working.

In the case of this prototype locomotive the engines are engaged or disengaged at predetermined speeds when either ascending or descending the speed range. These speeds are: first engine, 0–6 m.p.h.; second engine, 6–17 m.p.h.; third engine, 17–24 m.p.h.; and fourth engine, 24–78 m.p.h.

When shutting down, the final movement of the main regulator handle replaces all starting levers in the "stop" position. To reduce speed the regulator is shut down only to a point where it is checked by engaging with the starting levers, thus maintaining whatever position to which the levers were set. A two-position reverse lever marked "Forward" and "Backward," at the driver's right hand, is mechanically interlocked with the regulator so that it can only be altered when the regulator is shut right down. All vacuum controls can be isolated at either end of the locomotive by a master cut-out valve.

A vacuum brake valve is mounted conveniently for the driver's right hand in each cab and an instrument panel carries locomotive speed and engine r.p.m. indicators, oil pressure gauges, and engine starting switches, &c.

The locomotive equipment includes two carriage heating boilers, one each side of the central gearbox, with Laidlaw Drew automatic burner equipment. The feed water is preheated by the main diesel exhausts, the gases passing through tubular heaters situated outside the main frames adjacent to the bogies. A small water pick-up scoop can be used to replenish the boiler water tanks at troughs while the locomotive is running.

The main frames of the locomotive are of conventional plate construction well braced by horizontal and vertical plate stretchers. The main engine fuel tanks are arranged to form the stretchers above the bogie centres and carry the bogie centre pin on the underside.

All driving and coupled axles run on Timken roller bearings with laminated spring suspension, the axleboxes being situated between the outside coupling rod cranks and the wheels. The four-wheeled bogies are standard bolster units with 3ft diameter wheels and compensated laminated springs in cradles.

The gear ratios have been designed to give the locomotive a maximum speed of 78 m.p.h. when the four main engines are running at the maximum of 1500 r.p.m.

In this prototype locomotive, Fell Developments, Ltd., was responsible for the diesel engines, transmission system and associated equipment, and we are informed that it has arranged for Ricardo and Co. (1927), Ltd., of 21, Suffolk Street, London, S.W.1, to be responsible for the licensing and exploitation of the Fell inventions and provide consulting services for them.

Exhibition of Industrial Power at Kelvin Hall

No. I

THE Exhibition of Industrial Power in the Kelvin Hall, Glasgow, which was opened by Her Royal Highness Princess Elizabeth on Monday, May 28th, will remain open until August 18th, and is Scotland's equivalent to the South Bank display. Most appropriately, the exhibition is housed in Glasgow, as the city is the centre of a large area in which all forms of engineering are undertaken, from light industries to the construction of all sizes of engines and of ships, such as the famous "Queens" of the Cunard Line, which, although built before the war, are still the largest liners engaged in the Atlantic service.

The Power and Production Pavilion, forming a section of the South Bank Exhibition, has industrial power as its theme. At Glasgow, this theme is greatly enlarged and developed to demonstrate in particular the sources of power and man's conquest of them, together with accurately detailed items to support the history of achievement in heavy engineering. In the Kelvin Hall the exhibition is designed to tell a continuous story of the contribution of heavy engineering to the development of civilisation and its governing effect upon the life of the individual. The method adopted for presentation of the subject is such that both layman and expert are catered for. As depicted, the story is well calculated to hold the attention of the general public and the standard of the exhibits, together with the ingenuity employed to reveal their qualities, is of considerable interest to the technician.

Within the 200,000 square feet of floor space of the Kelvin Hall proper a series of eleven halls has been built to present the several aspects of the history of industrial expansion. This is based primarily upon the exploitation of coal and water which have been put to use, with a steadily increasing degree of efficiency, over a long period of time to speed up progress and constantly to change the economic outlook. Both of the primary sources of power expand into logical sequences.

Coal

The entrance to the beginning of the coal theme is at the head of a stairway leading from the Hall of Power and is cut through a semi-circular mural 105ft long, in which boldly impressionist figures in rugged relief set among rock formations link labour and production with prehistory.

As a symbol of the source of all power a man-made "sun," a sphere some 8ft in diameter, reigns over Britain's main source of power, namely, coal, which forms one of the main themes in the exhibition. The sphere, with a skin of aluminium, contains more than 500 lamps, giving an average intensity in excess of 750,000 candles, and includes mercury vapour lamps totalling about 16kW, emitting a light of high intensity, and filament lamps of about 12kW. Photo-flash equipment is fitted to give the effect of sun spots by a series of bulb chains from the centre to the surface of the sphere, where a bulb, of very high candle power, flashes. The lighting is so arranged that a moving shadow is formed and so gives the impression that the sun is rotating. A switching device gives a criss-cross or zig-zagging light, the switching being controlled by electronic apparatus. This electronic integrating and timing circuit sends out activating pulses for the control of the automatic switchgear operating 4000 separate contacts.

Hall of Coal.—Past the sun, the coal theme develops through a series of halls, which are devoted successively to mining, the history of the development of iron and steel, the working of metals, and the generation of power and electricity.

The mining scene begins in a coal swamp, where vegetation is in the first stages of decomposition and chemical change, which will turn it eventually into a coal seam. Pictorial models show the growth of the industry from the gathering of coal from drifts in the hillside to modern deep mining. Murals tell the story of the combination of coal and steel, leading to the machine age, and a diagrammatic display shows the geological formation of coal. From a platform a short descent is made in a mine cage to an exhibit representing conditions of two centuries ago, with models showing the work done by child and female labour, and the hazards faced by miners. Next follows a modern mine employing mechanical coal-cutters, and wall diagrams illustrate present-day organisation, with special reference to rescue work and rehabilitation of injured miners. An exploded model shows the layout of a pithead, and aids to safety include an automatic methane detector set to operate in the presence of 1¼ or 2½ per cent fire-damp in mines atmosphere, a fire-damp recorder, and flame safety lamps.

Hall of Steel.—The approach to the Hall of Steel is a compartment with walls

sheathed in stainless steel and a floor composed of a mosaic of polished steel sections of all shapes and sizes, representing standard productions of the mills. In the centre of the space is a half-scale model in Perspex of the largest ingot made in this country and illuminated to simulate white heat. A series of transparencies tell the early story of steel and a biographical sequence recalls the iron and steel masters, Darby, Bessemer, Brearley and Hadfield, who each contributed to the advancement of the technique of steel production and so made possible the availability of cheap steel and the modern machine age. The methods employed in the making of steel are illustrated and the progress made during the years can be noted by comparing contemporary prints of an early open-hearth with a modern open-hearth furnace. Examples of steels suitable for working at opposite ends of the temperature scale, such as in arctic conditions and blading for a gas turbine, illustrate modern research.

From the manufacture of steel there follows the shaping of metals, and a display of mediæval wrought ironwork dating from the fourteenth century reveals ancient skill. The work of the smith is continued in a smithy, which is equipped with modern tools such as a hearth, anvil and stand, swage block and quenching tank, and in which a skilled smith demonstrates his craft. The coming of steel and the increase in demand went beyond the capacity of the hand tools of the smith and the development of machine aids are traced from the water-driven tilt hammer to the steam hammer and from the early press to the huge hydraulic presses of to-day. A group of modern machines demonstrates the latest methods employed in the forming and shaping of metal.

Heavy forging work has its example and two films tell the story of other processes. One shows on the screen the manufacture of steel tubes at the works of Stewarts and Lloyds, Ltd., while the other illustrates the stages in the rolling of sheet steel and the preparation of pieces for forging. Casting technique is the subject of a display, set in front of a large casting, showing the stages of the work in the foundry for the production of castings.

There is an exhibit of highly finished precision instruments and also a range of machine tools. The important part played in industry by standardisation, and which is closely linked with the principles of mass production, is shown in a display of systems of measurement associated with the work of the British Standards Institution. For interchangeability of parts a high degree of accuracy is required and interesting exhibits show some of the latest instruments which are available for the toolmaker.

Power for Industry.—In natural sequence, the next stage is Power for Industry, and the approach to the various exhibits of steam generators and power units is prefaced by a historical survey of the application of steam as a driving force. The wheel and lever served until the increasing demand for power set men to harness the power of steam, and the display records the work of Thomas Savery, and Thomas Newcomen and then the invention of the condenser by James Watt, which resulted in the first practical steam engine, and was the first step in the search for efficiency. The improvements effected by Richard Trevithick in pioneering the high-pressure engine are shown, also the evolution of the boiler, and the machinery on view exemplifies the stage reached along the road of progress by 1951.

Hall of Electricity.—A huge portrait of Michael Faraday introduces the hall of electricity. A series of wall displays portrays the history of electricity, of how its effects were known in early times, such as the properties of the lodestone, and the electric batteries of the seventeenth century. Michael Faraday developed the theory to cover the known facts and made the first electric generator. From this turning point the pictorial display shows the application of the steam engine in the development of the early power stations and the limitations of this type of drive. The central figure of modern electrical development is Sir Charles Parsons, who evolved the first turbine in 1884 and so introduced the era of cheap electricity and the beginning of the electrical age in industry. A ½kW turbo-dynamo, similar in construction to the first Parsons machine, compares with a sixteenth-scale model of a 50MW turbo-alternator in a modern power station. The electrical power story moves logically to the huge output of a modern power house, representing generation and distribution to the grid system, and to machines and appliances representing consumption. There is a mural consisting of a line diagram of a 60MW hydrogen-cooled turbo-alternator, a series tracing developments in power cables and a display dealing with the a.c.-d.c. controversy. The hall houses a range of present-day electrical equipment and the final exhibit of two large terminal bushings symbolises controlled electrical power.

Water

From the Hall of Electricity a return is made to the Hall of Power and from this focal point steps rise under a glass tunnel upon which thousands of gallons of water per minute are being sprayed to create the impression of water power. The water theme continues through halls describing Scottish hydro-electricity developments and the wide field of civil engineering.

Hall of Hydro-Electricity.—The emphasis here is upon past and present conditions in the Scottish Highlands and is concerned with the decay of life before the development of the power schemes and its revival with the availability of electrical energy. The early schemes at Kinlochleven and Lochaber are noted and the vast projects of the North of Scotland Hydro-Electric Board are mapped out. The theme stresses the economic importance of using water and a series of photographic displays and captions describes the essentials of hydro-electric engineering. A mural shows men engaged in cutting the tunnels which link glen with glen.

In another section examples chosen from the Loch Sloy undertaking show the many aspects of the work involved in building a station and the future possibilities in the opening up of new industries and the working of unused raw materials by the advent of cheap electricity. Along the length of the outer gallery, which is dominated by a mural in thin bronze and brass sheet of a water horse or kelpie, the ancient legendary Gaelic creature of the Scottish rivers and lochs, a waterfall tumbles into the Hall of Civil Engineering. Two alcoves show how the beauty of the glens is preserved, Loch Affric being taken as an example, and how sport is unspoiled by the provision of fish ladders. The untapped raw resources in the shape of peat, of which fuel there is the equivalent of 400,000,000 tons of coal and which will be used as fuel in gas turbines at an early date, are illustrated. In the final alcoves the possibility of using the power of the winds is shown in a model of the Orkney windmill, and the Severn barrage as a means of using the power of tides.

Hall of Civil Engineering.—After displaying some examples of the work of the old builders, the hall demonstrates modern techniques in construction and the use of materials, such as cast iron, wrought iron, steel and the latest medium, prestressed concrete, which makes possible greater economy of construction. Space frames form the roof, and there are open web joists, sheet metal flooring, examples of cold-rolled sections, and the application of expanded metal, from its use on air strips down to grills of radio sets. A section at one side is devoted to bridge building from the early Clapper bridge to that spanning Sydney harbour, and including the aluminium alloy bridge at Pitlochry, while in the centre various photographic displays show the wide range of civil engineering and include such giant buildings as the "Brabazon" hangar, steel-frame buildings, docks and dock gates, and the achievement of the Mersey tunnel. Linked with public health, another section is concerned with a modern main water supply system, and a model shows the circulatory flow of domestic water from reservoir to sea with emphasis upon modern sewage systems.

One end of the hall treats the subject of irrigation and, in particular, the schemes which British engineers have undertaken in the Nile Valley. A vertical wall display develops the story on three levels, the uppermost shows the terrain, while the middle level gives two 15ft long plaster relief maps showing the Nile Valley as it was 5000 years ago and as it is to-day under man's control. The maps are animated and by means of a complex arrangement of plastic tubing channels, lighting circuits, moving shutters and a sound commentary, give a visual and aural story in one map of the alternate problem of drought and flood, floods in the Sudan, and how the Sud, a high area of marshland, absorbed the spate water. In the second map the story explains how a system of dams and canals is converting the area into one of great fertility by taming the White Nile floods, creating a vast storage lake of the Great Lakes, and by cutting a canal, in the future, through the Sud. Control and synchronisation of the 10,000 separate connections in the installation are effected by using the speech sound track to carry synchronising pulses to trigger the various independent sequences. Below the maps, photographs show ancient Egyptian methods of irrigation and the Owen Falls dam.

(*To be continued*)

The British Hydromechanics Research Association

The British Hydromechanics' Research Association was founded just over three years ago, its function being to further the knowledge and application of fluid mechanics in the construction and utilisation of hydraulic machinery and ancillary equipment. Full membership is open to manufacturers and users of such equipment, and consultant and academic workers are eligible as associate members. In addition to the income provided by members' subscriptions, the Association receives a grant from the Department of Scientific and Industrial Research to assist its work.

Until recently the Association's principal activity has been to provide a technical information service, but it has also set up several tech-

nical committees which have reviewed the work required to be done in members' interests and have planned a research programme. Soon after the Association was established it became evident that experimental facilities were essential in order to develop an efficient organisation. Although, owing to the Association's limited financial resources, it has not been possible to build a completely equipped conventional hydraulic laboratory, arrangements have been made to lease from the Harlow Development Corporation a specially built standard factory which has been suitably modified for the Association's needs, in the new town area of Harlow, Essex. For some months past, the work of the Association has been proceeding at Harlow, and on Thursday of last week its laboratory there was officially opened by the President, Sir John Anderson, F.R.S. The new building consists essentially of one large area 72ft by 120ft, with a raised portion across one end, and a two-storey block of offices of about 1800 square feet. A sump and well and pipe ducts have been provided, and about one-third of the area has been partitioned off for use as a workshop, generator room and oil laboratory. The office block contains space for instrument and photographic laboratories. The design of the building lends itself to the relatively easy erection of individual items of equipment as they are needed, and it is felt that there is some advantage in the absence of large permanent installations which might not be easily adaptable to the variations of future experimental requirements. It has not yet been possible, of course, to equip the laboratory on anything like an adequate scale, but, with the help of some generous gifts and by improvising second-hand equipment, a few test rigs have been assembled and are successfully demonstrating the Association's capability to deal with urgently required research. Work at present in progress includes the experimental measurement and theoretical analysis of pressure surges in pipelines; model tests on the prevention of vortices in pump suction inlets; examination of the effect of pulsations on the accuracy of flow measurement; measurement of pipe friction and reduction of losses in bends and fittings; the testing of seals and glands, and a study of the fundamentals of cavitation.

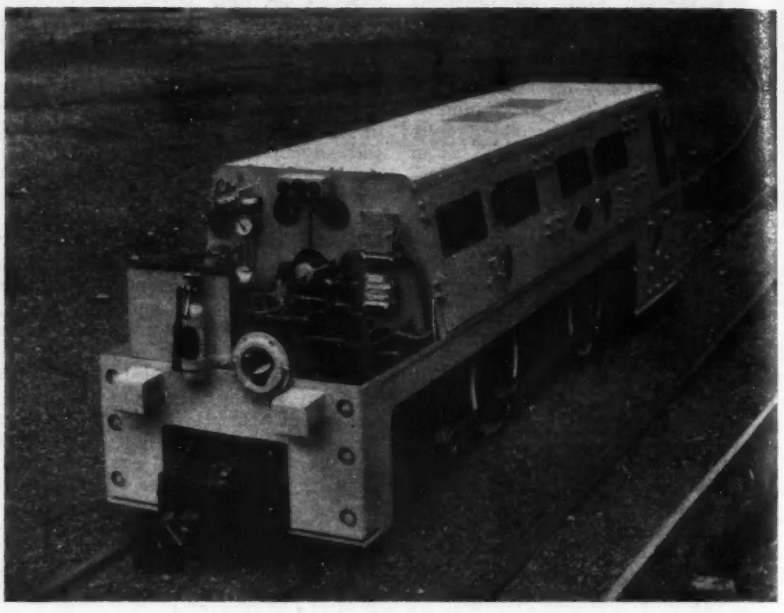
Mr. G. A. Wauchope, M.I.Mech.E., is chairman of the Association's Council, and the work at Harlow is guided by Mr. L. E. Prosser, M.I.Mech.E., director of research. Miss H. M. Dolman is the secretary of the Association.

The Institute of Transport

THE Council of the Institute of Transport has announced the election of Mr. A. B. B. Valentine as President for 1951–52. He will take office on October 1st. Mr. Valentine, who is the member of the London Transport Executive responsible for operation and commercial matters, was born in December, 1899, and educated at Highgate School and Worcester College, Oxford. After six years with the British Commercial Gas Association, he joined the Underground Group of Companies in March, 1928, and was engaged for a short time on publicity work, subsequently becoming an assistant to Mr. Frank Pick, the managing director. On the formation of the London Passenger Transport Board, Mr. Valentine was appointed personal assistant to Mr. Pick, and later served as the Board's fares officer, commercial officer and chief supplies officer. In January, 1946, he was appointed chief commercial officer, covering both the traffic side and supplies, and later in the same year became, in addition, operating manager (railways). When the London Transport Executive was set up in 1948, Mr. Valentine was appointed a full-time member. In the same year he was invited to join the London Plan working party which was constituted by the British Transport Commission. Mr. Valentine was elected to the Council of the Institute of Transport in 1943 and a Vice-President three years ago. He was awarded the Road Transport (Passenger) Medal in 1945.

Mine Locomotive with Hydraulic Transmission

WHEN the 100 b.h.p. "North British Miner" diesel mine locomotive was described in our issue of August 13, 1948, it was pointed out that its design was such that various types of transmission could be employed without involving major changes in chassis construction. We are informed by the North British Locomotive Company, Ltd., of Springburn, Glasgow, that, pursuing its policy of making the operation of the locomotive simple and proof against hand-



"NORTH BRITISH MINER" DIESEL LOCOMOTIVE

ling by unskilled personnel, the gearbox has now been replaced by a Voith-North British turbo-transmission unit.

A number of advantages have been obtained by the introduction of hydraulic transmission. Only three running controls are used—throttle, reverse lever and brake—and no gear changing or clutch operations are required. A higher tractive effort is developed than with mechanical transmission to give smooth starting and the torque curve is continuous and stepless as with electric traction. As the starting torque is applied to the wheels without shock, violent wheel slipping is avoided, and if it does occur the engine is prevented from racing. Engine stalling does not take place, for if the engine speed drops the output torque also falls rapidly until at idling speed no torque is transmitted to the wheels. It is also pointed out by the firm that acceleration is steady and rapid and shock loads are not transmitted to the engine.

The weight of the locomotive can be varied between 12½ and 15 tons, and the track gauge can be adjusted from 2ft 5½in to 3ft 6in. Locomotives built for gauges up to 3ft have the following principal dimensions:—

Length over buffer beams	15ft 1in
Width	4ft
Height	4ft 5in
Wheelbase	4ft 7in
Diameter of wheels	2ft
Minimum radius of curved track	45ft
Maximum speed	12½ m.p.h.
Tractive effort calculated at 25 per cent adhesion	8400 lb

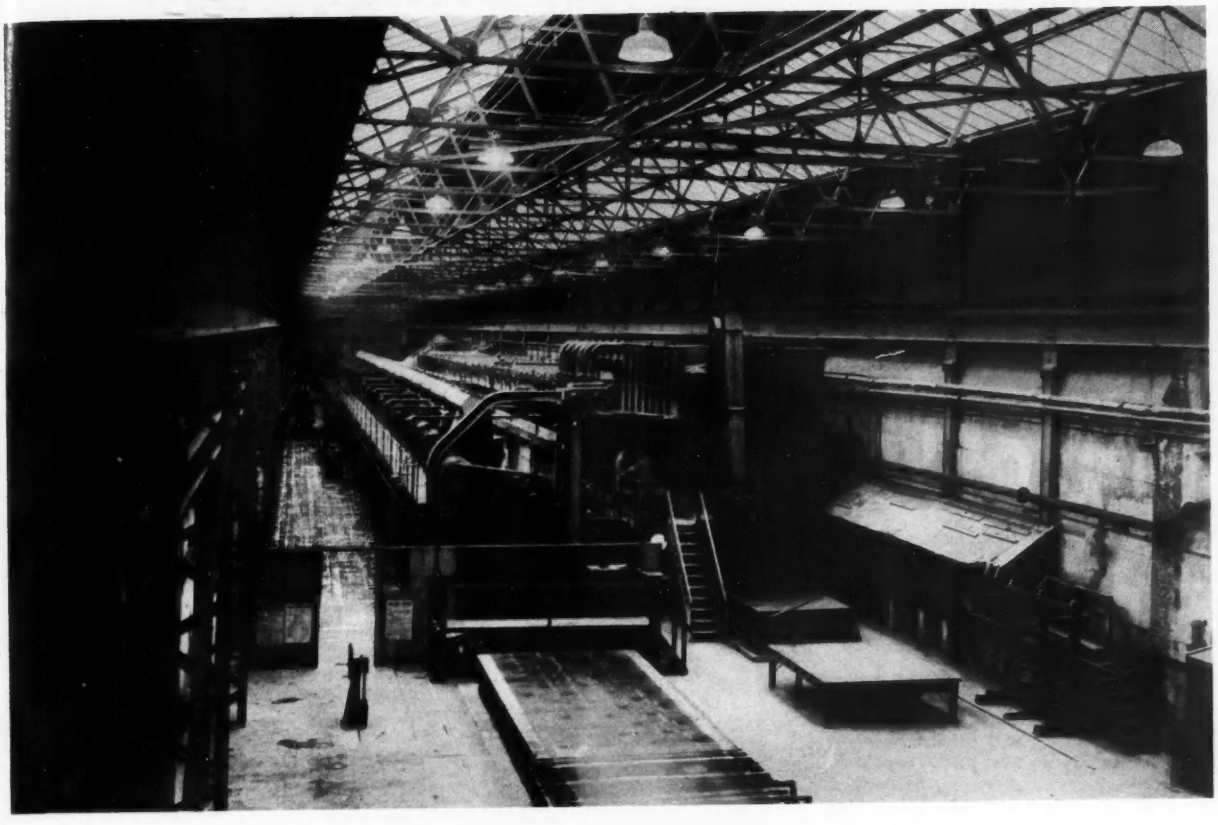
In preparing the design of the new "Miner" locomotives a number of modifications were made in the light of running experience with units of the original design. These modifications, whilst minor in themselves, improve the accessibility of parts which require periodic attention. The photographs we reproduce on this page show one of the new locomotives and a transmission unit.

The behaviour of the new locomotive fitted with hydraulic transmission is stated to be in striking contrast to engines fitted with any other transmission, and the driver, however unaccustomed, rapidly acquires confidence through the complete absence of multiple controls. Movement of the throttle lever away from the idling position opens a filling valve in the delivery line from a centrifugal pump in the sump of the transmission casing, and the locomotive immediately gathers way. The drive is taken through a torque converter until the speed has reached about 6 m.p.h. At this stage a mechanical governor driven by the output shaft in the transmission comes into operation and the oil is directed from the pump to a fluid coupling, the torque converter emptying while the coupling is being filled.

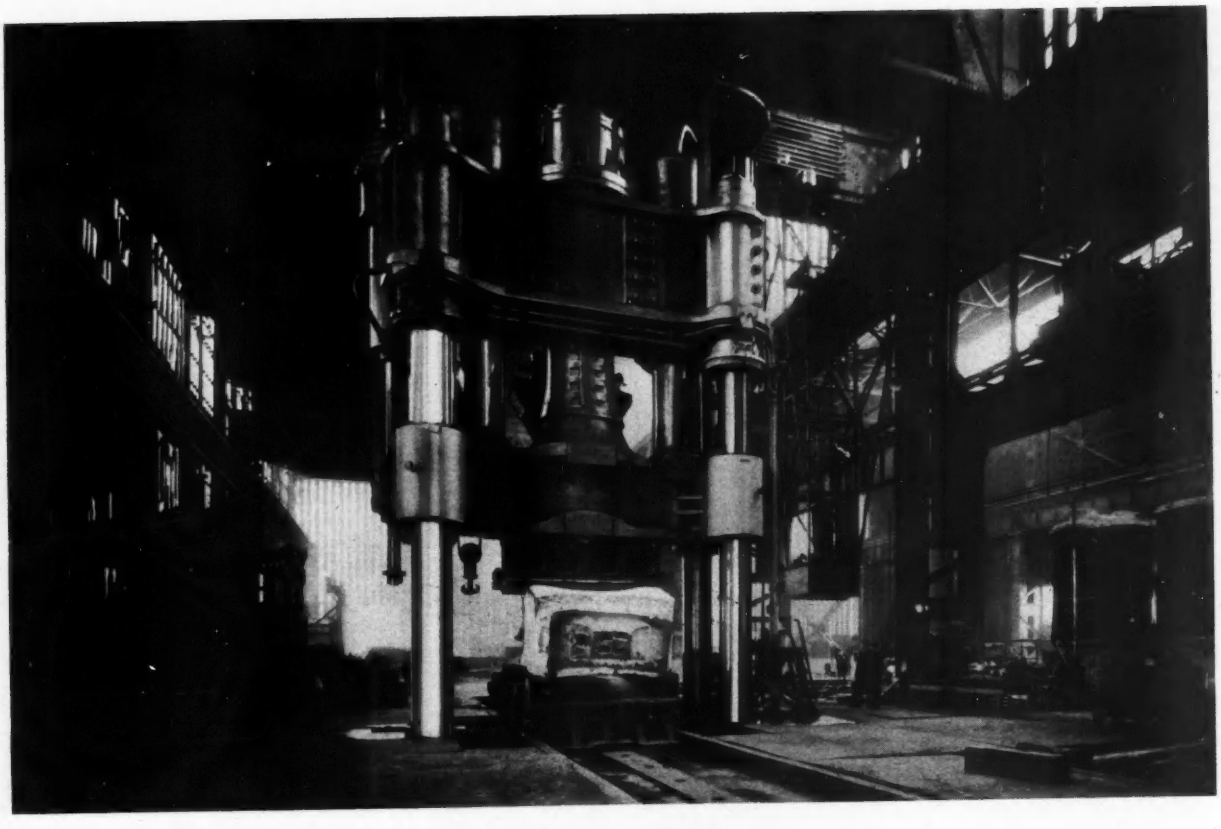
The change over is quite automatic and requires no attention from the driver. The transmission consists basically of two fluid circuits, the torque converter and the fluid coupling, the former for starting and low speed, and the latter for the upper range of speed in which its well-known characteristic of high efficiency at high speed is fully developed. On reaching greater resistance at the rail when entering a grade, the reverse process of changing down to the torque converter is equally automatic and simple. The onus of changing gear at the correct point is therefore removed from the driver, and there is no wear and tear on clutches and gears.

HYDRAULIC TRANSMISSION UNIT

ORIGINALS OF MODELS AT THE SOUTH BANK EXHIBITION

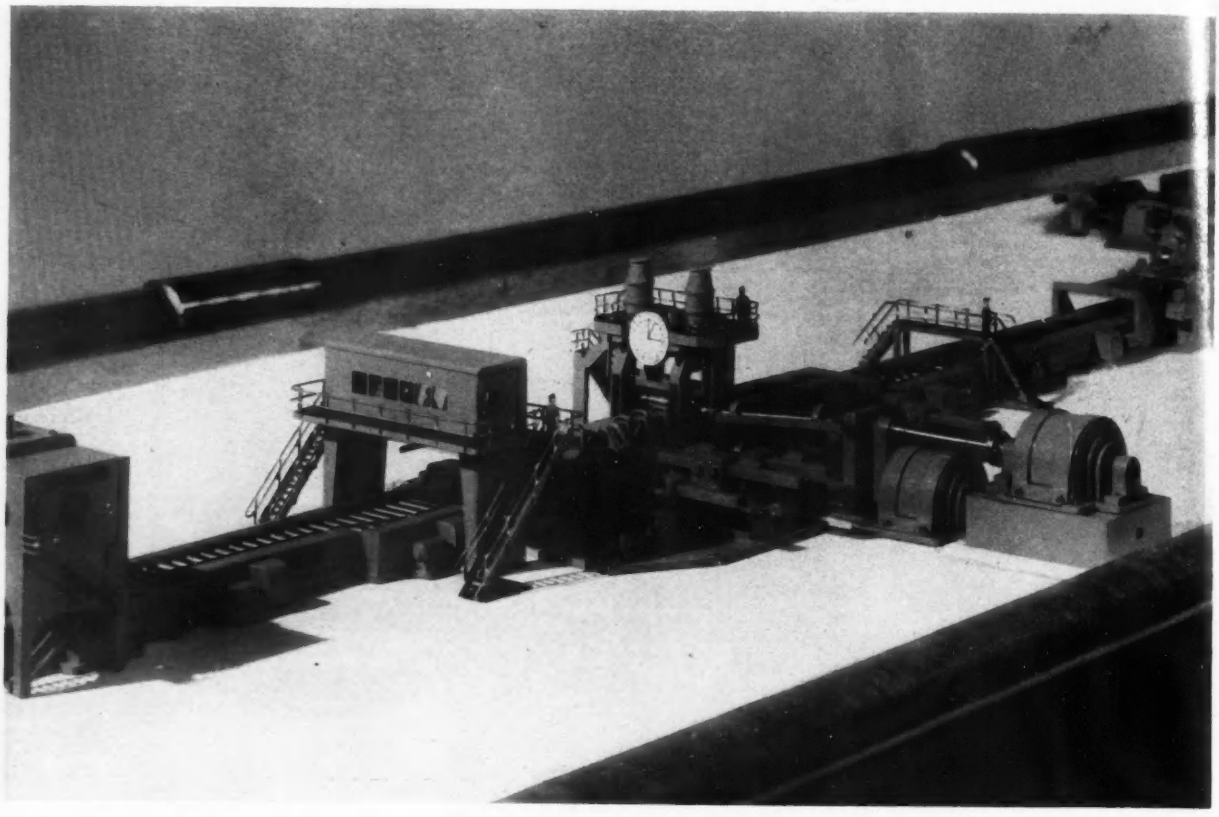


PILKINGTON PLATE GLASS TWIN GRINDING MACHINE

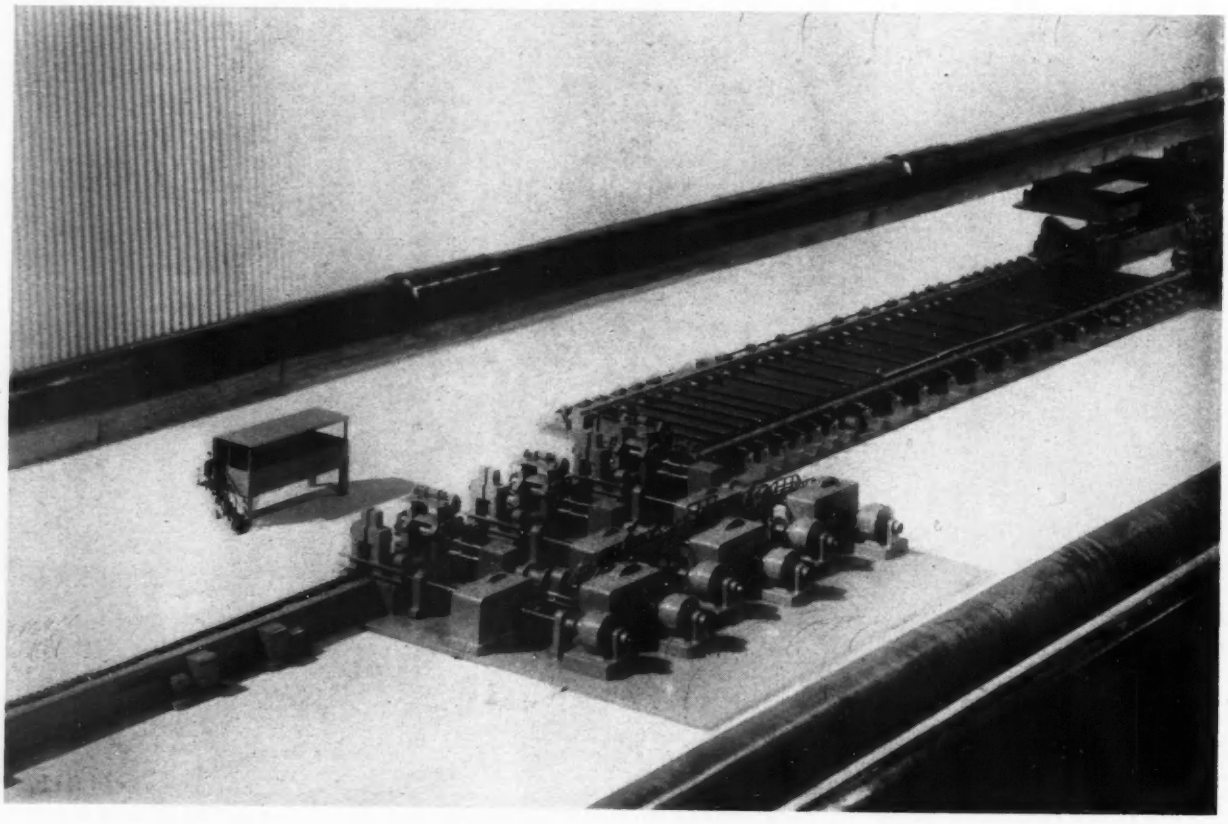


DAVY 6000 TON FORGING PRESS

MODELS AT THE SOUTH BANK EXHIBITION



MODEL OF DAVY BLOOMING AND SLABBING MILL

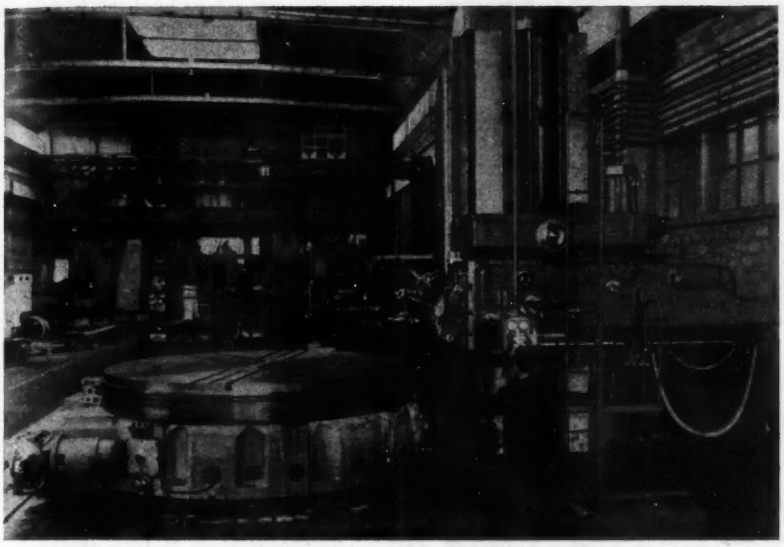


MODEL OF DAVY CONTINUOUS BILLET AND SLAB MILL

Hanover Technical Fair

No. III—(*Continued from page 694, May 25th*)

AMONG the large machine tools at the Fair was the milling and boring machine of the floor table pattern, which was shown by Société Nouvelle de Construction de Machines-Outils et d'Outillage Procédés C.W.B., of Paris. A view of this machine, with its rotary table, is given below. At the Fair it was shown with the universal head illustrated, and it was used for milling a circular casting. The spindle slide consists essentially of two spindles, one for milling and the other for boring, the boring spindle extending through the milling spindle. The spindle slide and all the bearings are designed for the use of tungsten carbide-tipped milling and boring tools.



HORIZONTAL BORING AND MILLING MACHINE—C.W.B.

In the machine shown, the diameter of the boring spindle is 147·5mm and that of the milling spindle 204mm. The longitudinal travel of the boring spindle is 1500mm and the spindle slide 750mm. The cross travel of the spindle column is 3500mm and of the boring bar support column 1000mm. The spindle head has a vertical travel of 2000mm and the maximum height of the spindle centre to the top of the table is 870mm. The spindle speed range is 2·6 to 640 r.p.m. and a rapid traverse provided for all movements gives a speed of 2200mm per minute. The stepless feed range is from 0·064mm to 1600mm per minute. The variable speed driving motor has a speed range from 600 r.p.m. to 3600 r.p.m. and a power range from 28 b.h.p. to 40 b.h.p., while each of the feed motors is 8 b.h.p. at 2400 r.p.m. The machine is controlled from a pendant box suspended from an overhead crane and with this control an operator can stand in the most convenient position for observing his work.

The British representatives of C.W.B. are Henderson and Keay, Ltd., of Old Angus House, 5, Oswald Street, Glasgow, C.1, and Dowding and Doll, Ltd., of Greycoat Street, London, S.W.1.

Two planing machines were shown by Adolf Waldrich, Coburg G.m.b.H., of Coburg, Bavaria, and, as will be seen from our illustration on this page, the smaller, open-sided machine was placed on the table of the larger double-column machine. The large machine can handle work up to lengths of 7000mm and 2000mm high and wide. The small machine takes work 1250mm long, 400mm high and 600mm wide. Both these machines are hydraulically operated. The cutting and return motions of the table are imparted through a variable delivery single-stage pump, with mechanism for reversing the flow of oil. With this oil-hydraulic system it is claimed that a good power performance is incorporated with a wide range of forward and return speeds. Movements are controlled by a hand lever in the smaller machines and by push-button control through a pendant box for the larger planers. Machines with this particular type of drive are built by the company for planing work up to over 42ft. The firm of Waldrich Coburg is represented in Great Britain by Drummond Asquith (Sales), Ltd., of Birmingham and London.

The possibility of machining several surfaces at a single setting, such as machine tool parts or engine crankcases, has caused more attention to be given to the production of large plano-milling machines, several of which were to be seen in the Fair. Two typical examples of this class of machine tool are shown on page 732.

Gildermeister and Co. A.G., of Bielefeld, showed a machine with one vertical and two horizontal spindles. Each milling unit has its own driving motor and speed controls. The table has a working surface 3000mm long by 1350mm wide, the front bearing spindle being 160mm diameter and 300mm long, and it incorporates a means of axial fine adjustment. The distance between the columns is 1800mm and between the horizontal spindle noses from 1050mm to 1150mm. Between the table and the centre line of the horizontal spindles the setting range is 200mm to 1150mm and between the table and the vertical spindle 200mm to 1550mm. The eighteen feed speeds range from 12mm to 600mm per minute with a rapid traverse of 3000mm per minute. The firm of Gildermeister and Co., is represented in this country by Soag Machine Tools, Ltd., 7, Juxon Street, S.E.11.

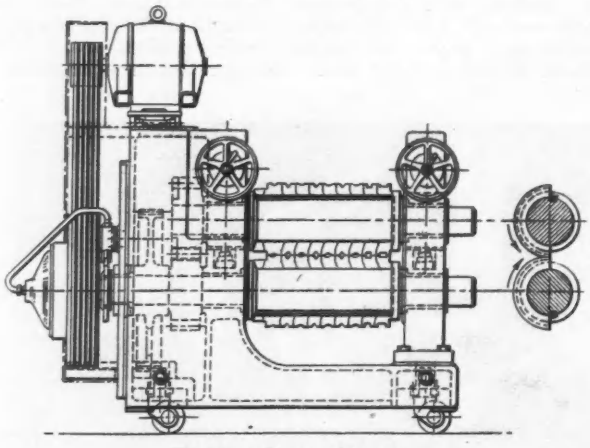
The other machine, on page 732, is that shown by Köllmann Maschinenbau G.m.b.H., of Langenberg, Rhineland. Following the firm's practice the design of this machine includes cellular ribbing for the bed-plate and columns. The motors are of the enclosed air-cooled polechanging type and drive the milling spindle through a gearbox giving sixteen speeds, ranging from 12 r.p.m. to 600 r.p.m. or 24 r.p.m. to 1200 r.p.m. Fine axial adjustment of the milling spindle up to 300mm can be made by means of a handwheel on the spindle casing. The table motion is obtained through a worm and rack drive, running in an oil bath and table feeds of the order 16mm to 500mm per minute are provided. For the larger machines the controls are worked from a push-button pendant control box. All motor switchgear is housed in a separate switch cubicle alongside the machine.

A multiple drilling unit, shown by Burkhardt and Weber K.G., of Reutlingen, Würtemburg, comprised three of the firm's multi-spindle drilling machines with hydraulic feed. Between the three machines a

LARGE AND SMALL PLANERS—WALDRICH

FOUR-SPINDLE MILLING MACHINE—GILDERMEISTER

FOUR-SPINDLE MILLING MACHINE—KOLLMANN



FORGING ROLLS—EUMUCO

transfer mechanism is arranged for the automatic machining of an internal combustion engine cylinder. On this set-up the cylinder is drilled on four sides and the hole for the sparking plug bored at an inclined angle. At each working station the workpiece is indexed by two holes and the cylinder travels between the units on hardened ways over 900mm in length. The clamping and positioning of the workpiece under each machine is done through hydraulic cylinders working in conjunction with locating pins operated by hydraulic plungers. All electrical controls for the group of drilling units are grouped in a desk with push-button controls.

A new exhibit seen on the stand of the Eumuco Aktiengesellschaft für Maschinenbau, of Leverkusen-Schlebusch, was the forging rolls, illustrated herewith. The rolls are designed for the preforming of forgings and workpieces, which are to be finished by drop hammer. The general construction is shown in the accompanying drawing. The drive from the electric motor is transmitted through a flywheel and single-plate friction clutch and brake. When forging is in progress, the rolls turn through 180 deg. and then reverse, returning to the original position. Along the roll surface there are different passes with progressively altering matrices for producing the shape finally required. The hot bar is taken from the furnace and fed into the rolls, the tongs forming a stop, and successive passes complete the preforming process in a very short time. The machine, which is mounted on wheels and is easily transportable, is designed to deal with work having lengths up to 530mm.

The Eumuco horizontal forging and upsetting machine can exert pressures up to 200 tons. The pressure is easily controlled through a handwheel in the front of the machine-head. The drive is by electric motor, through a flywheel and an air-operated friction clutch and brake. The horizontal jaws are accessible from three sides and the upsetting ram can be adjusted or removed from either side of the machine. The dies are simply fixed by movement of a hand lever and the dimensions of the jaws enable ordinary press tools to be employed. The manufacturer is represented in England by Winfield-Smith and Co., Ltd., Bourne Hill, Horsham, Sussex.

(To be continued)

The Royal Ordnance Factory, Radway Green

In the course of a series of visits to Royal Ordnance Factories in the United Kingdom, arranged by the Ministry of Supply, we recently saw at the R.O.F., Radway Green, near Crewe, some of the processes involved in the production of 0·303in Mk. VII ammunition and 20mm cannon shells.

For this kind of ordnance the plant at Radway Green is the largest in this country. It was begun during the severe winter conditions prevailing in 1939, the contractors having recourse to blasting operations during excavation and to portable heating units for the concrete aggregate. It later employed a peak labour force of 15,000, of which 10,000 were women. The "civil" work undertaken in the early post-war years included the production of electric and gas cookers, sparking plug bodies and non-ferrous strip metal, and with this work the factory was able to retain a nucleus of skilled workers with which later to resume the manufacture of ammunition.

0·303in Mk. VII Ammunition

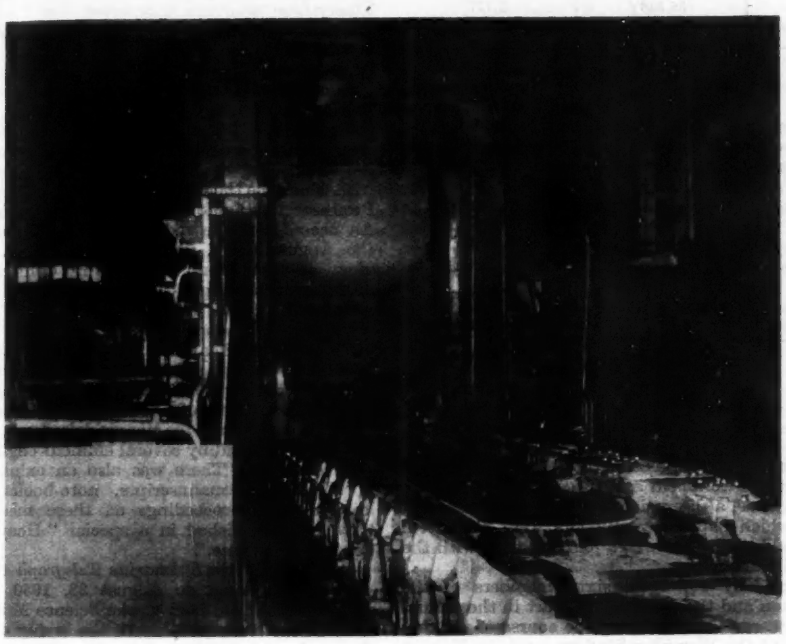
The manufacture of 0·303in ammunition has undergone few changes since its inception. The bullet, however, once formed with an almost pure copper jacket, has now a bi-metal envelope surrounding the bullet core, which, apart from effecting an 80 per cent saving in copper, is regarded as a more suitable jacket. The bi-metal strip from which it is made consists of a steel core sandwiched between layers of 90/10 brass and was supplied during the war from the U.S.A. A simple and economical method of producing such strip in this country has now been developed at the Radway Green plant. The assembly before processing consists of a central steel flat 1in thick, having small top and bottom flanges along its length, which are caulked over at intervals upon the brass plates 0·02in thick placed above and below. The composite strip is then heated and after several passes through a Davy United hot reversing mill is reduced to what is virtually a gilded steel strip 0·031in thick. The steel strip-edges formed by the flanges during rolling are later removed.

The cartridge case itself is a 70/30 brass, and the foundry is equipped with several Ajax-Wyatt electric induction furnaces, each capable of a ½ ton cast of cartridge brass every one and a half hours. The metal is poured into water-cooled moulds, each having

twin vertical compartments, and the slabs as cast are then trimmed and the dead heads sawn off.

Reheating takes place in a Gibbons-Wild Barfield electric billet heating furnace from where the slabs proceed to a reversing hot mill running parallel to the bi-metal mill and of similar design. Both the reheating furnace and the rolling mill are operated from a single control panel. During the rolling process the slabs are subjected to seven passes, after which the resulting strip is sheared into lengths, passed through a Torrington surface miller, and again parted, this time longitudinally by four equal slits on a Robertson rotary shearing machine. There are then three passes through a Farmer Norton cold finishing rolling plant before annealing and pickling. The strip finally passes through the straightening rolls of a Robertson flattening machine.

During a brief stay in one of the machine shops we saw some of the blanking and cupping machines, some of which we noted were by



HOT ROLLING MILL FOR BI-METAL STRIP

Taylor and Challen Ltd. From the brass cup the cartridge case assumes its full length after four stages of drawing, the machine associated with each stage employing two dies in series. The blank is annealed after each stage. Indentation of the base follows, and the blanks proceed to horizontal heading presses where the base is fully headed, rimmed and pierced. For these operations, in order to assist location in the presses, the blank is temporarily necked. The case thickness by this time has also received a taper towards the mouth. The final operation before filling is that of turning the rim and reaming the mouth.

Filling and Assembly

The filling and assembly of 0·303 Mk. VII ammunition is undertaken in a separate building of the loading factory, entry into which was attended by the customary safety and security precautions associated with these processes. The lay-out is so arranged that empty components arrive at one side of the factory and move from operation to operation until the cartridges have been completed, weighed, gauged and inspected, and are ready for dispatch.

The incoming cartridge cases are trayed and then have percussion caps fitted into the heads. The percussion caps, though made from a 95/5 brass and cupped and formed at this plant, are filled elsewhere. Strands of cordite fed from flameproof outhouses are automatically inserted into the cases, which are then formed at the mouth to receive the bullet. The mouth is previously coated with a varnish moisture seal. Finally, the bullets are inserted to the required length, the cartridge case is caused to grip the bullet, and the assembled round of ammunition is then corrected to shape so that it is a true fit into the chamber of the machine gun or rifle. The finished ammunition is then automatically gauged and weighed.

20mm Cannon Shells

The 20mm ammunition is comprised of ball, high explosive, armour piercing, incendiary and tracer shells, the manufacture of which varies slightly according to the shell. There is a production line associated with each kind of shell and an improved plant lay-out and system of inspection has recently been adopted. The production line consists of a central conveyor belt alongside which are disposed on both sides multi-spindle automatic machines. The blanks from each machine are fed directly on to the belt and the inspection system provides for intermediate checking, where and when necessary, on every shell as it proceeds down the line, thereby enabling immediate correction to be made to any particular tool. In the case of ball ammunition, manufacture of the complete shell is effected almost entirely on Acme-Gridley six-spindle autos. On these machines the blank is turned, the base formed and drilled, the driving band groove cut and knurled, the nose formed, and finally parted off.

An auto-setter's training shop has been set up to supply the necessary number of men skilled in the tooling up of this kind of automatic machinery.

The establishment is equipped with modern laboratories and tool and gauge-making plant, and part of its experimental and development work has been the development of the new 0·280in ammunition.

Institute of Physics.—At the recent annual general meeting of the Institute of Physics, Professor W. E. Curtis, of the University of Durham, was re-elected President, Dr. J. Topping was elected a Vice-President, and Mr. O. W. Humphreys and Dr. S. H. Piper were elected ordinary members of the board. The annual report notes, among other matters, that the system of granting official recognition, after inspection by the Institute, to technical colleges whose standard of teaching physics is considered adequate, has resulted in substantial improvements in their facilities. The report says that thirty-three colleges have now been recognised.

The Institution of Electrical Engineers

The report of the council of the Institution of Electrical Engineers for the session 1950–51 was presented at the seventy-ninth annual general meeting of the Institution on May 17th. Abstracts from the report are reproduced herewith.

Membership

The rate of increase in the membership of the Institution has been well maintained during the session, the number of newly elected members being 2431, as compared with 2559 during the previous session. The membership committee dealt with 2123 other applications, mostly for transfer from one class to another, making a total of 4554. On April 1, 1951, there were 26,399 corporate members and graduates on the register out of a total membership of 36,558, and the number of graduates increased during the year to 9253 (8520 in 1950). As these have complied with the examination requirements for associate membership they will be eligible for transfer to that class when their practical training and responsible experience in their profession are of the required standard.

The growth of membership in the past fifteen years is shown in the table overleaf.

As announced at the ordinary meeting on January 11, 1951, the council has elected Mr. P. V. Hunter, C.B.E., Past-President, to honorary membership of the Institution for his outstanding services to the electrical industry and to the Institution.

The council has made the twenty-ninth award of the Faraday Medal to Dr. T. L. Eckersley, B.A., B.Sc., F.R.S. (Member), for his achievements in the field of radio research and, in particular, for his outstanding contributions to the theory and practice of radio-wave propagation.

By-Law Amendments

On the recommendation of the general purposes committee, the council, on October 19, 1950, placed before a special general meeting of corporate members its recommendations for a number of amendments to the by-laws of the Institution.

Among the changes, the most important were in the by-laws expressing the requirements for entry to the various classes of membership, opportunity being taken in particular to set out with greater clarity the three essential requirements for associate membership, that is to say, an adequate general and electrical engineering education, adequate practical training and adequate responsible experience as an electrical engineer. A duty was also placed upon those seeking election as students to satisfy the council of their intention to meet the requirements for admission to the class of graduates.

The constitution of the council has received attention, the former proviso that there should be eighteen ordinary members of council being changed to a requirement that there shall be not less than eighteen and not more than twenty-one such members as determined by the council from time to time. This will enable a more uniform sequence of annual retirements and elections of ordinary members of council to be achieved.

Institution Activities

During the twelve months ended March 31, 1951, 1162 meetings of the members, the council and the various committees were held in London and at the local centres. Eight ordinary meetings were held in London, with an average attendance of 267, as compared with 255 for the previous year. One of these meetings was devoted to a commemoration of the centenary of the birth of Oliver Heaviside. In addition, the Institution participated in a joint meeting with the Institution of Mechanical Engineers. Two extra meetings and the annual general meeting were also held.

A public meeting was held at the Central Hall, Westminster, London, for the delivery

of the 1950–51 Faraday Lecture by Mr. L. J. Davies, M.A., B.Sc., on the subject of "Lamps and Lighting—A Record of Industrial Progress." The lecture was repeated at public meetings held in Nottingham, Birmingham, Rugby, Liverpool, Manchester, Swansea, Sheffield, Southampton, Newcastle-upon-Tyne and Edinburgh. The forty-first Kelvin Lecture on "Lord Kelvin's Contributions to Surface Chemistry," was given in the Lecture Theatre of the Institution by Professor E. K. Rideal, M.B.E., M.A., D.Sc., F.R.S.

The membership of the four specialised sections continues to grow; particulars of this growth and of the activities of the sections are summarised herewith :—

Growth of Membership

Year (March 31st)	Corporate Members	Non-Corporate Members	Total Membership	Annual Increase
1937	8,842	8,557	17,399	611
1938	9,110	9,142	18,252	853
1939	9,462	9,582	19,044	792
1940	9,838	10,034	19,872	828
1941	10,121	10,154	20,275	403
1942	10,483	10,567	21,050	775
1943	11,097	11,218	22,315	1,265
1944	11,924	12,634	24,558	2,243
1945	12,573	14,091	26,665	2,107
1946	13,447	15,711	29,158	2,493
1947	14,501	16,759	31,260	2,102
1948	15,206	17,701	32,907	1,647
1949	16,027	18,344	34,371	1,464
1950	16,648	18,900	35,548	1,177
1951	17,146	19,412	36,558	1,010

Membership of Specialised Sections

	Membership at March 31, 1951	Number of Meetings	Average Attendance (Figures for last year in brackets)
Measurements Section	1,941	13	101 (102)
Radio Section	4,636	16	147 (112)
Supply Section	3,348	8	169 (149)
Utilisation Section	3,401	8	104 (87)

Measurements Section.—Two symposia of papers have been presented during the year. The first, on "Radiation Monitoring Apparatus," comprised two sessions and was held on November 28, 1950, when seven papers were read. A second symposium, on "Electrical Meteorological Instruments," also of seven papers, occupied two sessions on January 30, 1951.

In view of developments in automatic control and servo systems and their importance to the armed services and in industry, it was arranged that papers of a high academic level, covering the latest investigations into control technique should be included in the sessional programme and this policy will be continued. The annual lecture was delivered on May 2, 1950, by Professor L. F. Bates, Ph.D., B.Sc., on "Recent Ideas and Experiments in Magnetism." A conference on Electrical Instrument Design, was arranged for May 28 to 30, 1951.

Radio Section.—The radio section has organised sixteen meetings, one jointly with the Utilisation Section, and has participated in a further four jointly with the Measurements Section. The programme included, besides Captain C. F. Booth's inaugural address as chairman, seven meetings devoted to the presentation of papers, five discussion meetings, two informal lectures, and one special lecture.

Forty-five papers have been submitted for the consideration of the Radio Section committee, as compared with seventy-four during the corresponding period last year; the reduction is due to more rigorous security rules necessitated by the international situation.

The section committee, with the support of the council, is proceeding with plans for a six-day convention in the spring of 1952, under the title of "The British Contribution to Television." At this convention papers will be presented covering all aspects of television, and a number of visits will be included in the programme.

Supply Section.—The Supply Section has had a most successful year, with a record average number of papers received by the committee was seventeen as compared with twenty-seven in the previous year. In addition to those read at meetings five papers were accepted for publication only.

Utilisation Section.—Once again the year was notable for a marked increase in the attendance at its meetings and a record number of participants in the summer visit, which was held in Stratford-upon-Avon in September 1950, and was attended by 263 members and guests. The eight section meetings included the annual lecture given by Mr. C. W. Marshall on "A Review of Research in Electricity Supply," and in addition one Supply Section paper was read at an ordinary meeting. The total strength and popularity of the Section. Eight meetings were held and these included, for the first time, a discussion meeting and a meeting at which papers by students were presented. In addition, there was a joint meeting with the Radio Section.

On May 19, 1950, sixty members of the section and their ladies took part in the annual summer visit and during the course of the day visited the Wembley Stadium and the Empire Pool and Sports Arena, and Hatfield House, Hertfordshire.

A conference under the title "Electricity as an Aid to Productivity," was held in the Institution building on November 15 and 16, 1950. The main purpose of the conference was to keep non-technical production executives in industry abreast of the latest methods and techniques of increasing productivity by means of electricity. A report of the proceedings has since been published in order still further to disseminate knowledge of the matters dealt with at the conference.

Local Centres and Sub-Centres.—The membership of the centres on January 1st, 1951, was as follows :—

East Midland	1127
Mersey and North Wales	1201
North-Eastern	1290
North Midland	1815
North-Western	2790
Northern Ireland	300
Scottish	1541
South Midland	3046
Southern	1484
Western	2034

The South Midland achieved its jubilee, the fiftieth anniversary of its foundation having been celebrated with appropriate ceremonies, including a jubilee dinner, a jubilee exhibition at the Birmingham College of Technology and the publication of a history.

Students' Sections.—At the annual conference of hon. secretaries, held in February, 1951, encouraging reports were received of the increases in many sections of attendances at meetings. In those sections where attendances have not increased it seems probable that the downward trend has been arrested and that better results will be obtained during the coming sessions. Dr. K. J. R. Wilkinson and Mr. L. Drucquer are delivering this year's Students' Lectures on the subjects of "Research in Electrical Engineering" and "Switchgear" respectively.

Sixteen members drawn from many Students' Sections attended the summer tour to Holland from July 1 to 15, 1950. An interesting itinerary included visits to a power station in Amsterdam, the enclosing dam of the Ijssel Lake, the Heemaf factories at Hengelo, the K.E.M.A. laboratories at Arnheim, the Philips' factories at Eindhoven and the Maas Tunnel at Rotterdam. There were a number of other sight-seeing trips and the party were the guests at a reception arranged by the council of the Royal Netherlands Institution of Engineers, whose secretary, Mr. Sangster, had kindly organised the programme of technical visits.

For the first time since the war a students' summer meeting took place in this country. This was held on August 14 to 18, 1950, in Scotland, and was organised by a special sub-committee set up by the Scottish Centre. Thirty-four students completed the full programme of visits and twenty-three members of the Scottish students' section took part on a day-to-day basis.

Summer Meeting.—A summer meeting of the Institution was held on July 4th to 7th, attended by 195 members and their ladies, and it was appropriate that this took place in Cambridge, a centre of scientific learning, with which the then President of the Institution, Professor E. B. Moullin, is closely associated. An account of the meeting was published in the August, 1950, issue of the *Journal*. In view of the Joint Engineering Conference, no summer meeting of the Institution has been arranged for 1951.

Oliver Heaviside.—The centenary of the birth of Oliver Heaviside occurred on May 18, 1950, and to mark the event two commemorative meetings were held during the afternoon and evening of that day, when papers were read relating to Heaviside's work, and tributes were paid by several eminent engineers and scientists. There was also an exhibition of Heaviside's manuscripts, note-books and letters. The proceedings at these meetings have been published in a special "Heaviside Centenary Volume."

Centenary of the Submarine Telegraph Cable.—At the opening, on August 28, 1950, of a special exhibition, held at the Science Museum to celebrate the centenary of the laying of the first submarine telegraph cable, Sir George Lee, O.B.E., M.C., Past-President, deputising for the President of the Institution, gave a short address, which included some personal experiences of the early days of cable laying.

Committee on Electrical Exhibitions.—Following upon an invitation from the British Electricity Authority and Area Boards and from the British Electrical and Allied Manufacturers' Association, the Council has set up a committee for exhibitions dealing with progress in electrical science and engineering with the following terms of reference : "To propose, consider suggestions and co-ordinate arrangements for exhibitions, whether permanent or temporary, dealing with the history and progress of electrical science and engineering and their applications." In collaboration with the director of the Science Museum and senior officers of his staff, the committee has under review the arrangements at the museum for the display of collections of electrical engineering interest, and has presented to the council an interim report conveying its proposals for the re-staging and extension of the electrical power collection. The committee proposes in due course to consider the other electrical collections, as, for example, those dealing with electricity and magnetism, telecommunication and electric transport.

Exhibitions of Developments of Outstanding Scientific Interest.—Further exhibits, including displays dealing with the composition, behaviour and application of ferrites, and the use of polythene in telecommunication cables have been shown under the scheme approved by the council for the exhibition from time to time

in the Institution building of novel or specialist equipment of outstanding scientific interest.

Education

The education and training committee of the council have met eleven times during the year and have made a number of recommendations affecting the policy of the council on educational matters.

The problem of the future development of higher technological education in technical colleges has been one of the principal subjects before the committee, who have had under careful review the recommendations of the National Advisory Council on Education for Industry and Commerce in association with the education committees of the Institution of Civil Engineers and the Institution of Mechanical Engineers, two meetings have been held with representatives of the National Advisory Council, who were made aware of the views which the councils of the three Institutions had formed as a result of their accumulated experience in this field. The council of the Institution regret to note that in the final report of the National Advisory Council the views put forward by the three Institutions have received but little attention; in response, therefore, to the Minister's general invitation in issuing the Advisory Council's report, the council have submitted alternative proposals, which they consider would bring about the development of higher technological education on lines that would be fruitful of result and in keeping with national needs. The council have felt it necessary to make it clear that they could offer their full co-operation only if the proposals in the report of the National Advisory Council were suitably modified to avoid the serious defects which have been pointed out. At the time of the preparation of this report the council await an opportunity to explain these matters more fully to the Minister.

The committee have also considered proposals for the establishment of National Certificates in Mining Engineering and the relationship of these proposed certificates with the existing National Certificates in Electrical Engineering; preliminary discussions have taken place with the Institution of Mining Engineers, the body which, with the Ministry of Education, will be responsible for these awards.

On behalf of the council the committee have also taken a close interest in the scheme for the award of Athlone Fellowships to enable young Canadian graduates to undertake their practical training in this country and the council were glad to be able to participate in the arrangements made for a party of Canadian Professors of Engineering to visit this country in the summer months.

Works-Based Sandwich Courses.—The Minister of Education has personally supported the proposals made by the councils of the three Institutions for the development of works-based sandwich courses in technical colleges and, during the year, discussions have continued in order to clarify some of the details. The council are pleased to note that one such course was inaugurated last autumn and they hope that its early promise of success will lead to the establishment of further courses.

Advanced Studies in Electrical Engineering.—Reference was made in the annual report for 1949–50 to the conference called by the council in March, 1950, to encourage the development and provision of advanced courses of study in electrical engineering; a report of the proceedings at this conference has since been published. During the past session the council have been pleased to note the growing provision of these courses in several parts of the country and the reports of the Regional Advisory Councils for Further Education indicate that this development can be expected to continue.

Joint Committee on Practical Training.—The Joint Committee on Practical Training, which is representative of the British Electrical and Allied Manufacturers' Association, the Radio Industry Council and the Institution, have for two years had the subject of the education and training of electrical technicians under consideration and in July, 1950, a report, which the committee had prepared, was published.

The report was presented by Sir Arthur P. M. Fleming, Past-President, at an ordinary meeting of the Institution in November, 1950 (*Proceedings, I.E.E.*, 1951, 98, Part I, page 28). As a result of the publication of the report discussions are taking place with the City and Guilds of London Institute on the possibility of that Institute implementing some of the recommendations, particularly those relating to the provision of specialised courses of instruction. Discussions are also proceeding in the Joint Committee for National Certificates (England and Wales) for the provision of similar courses within this scheme.

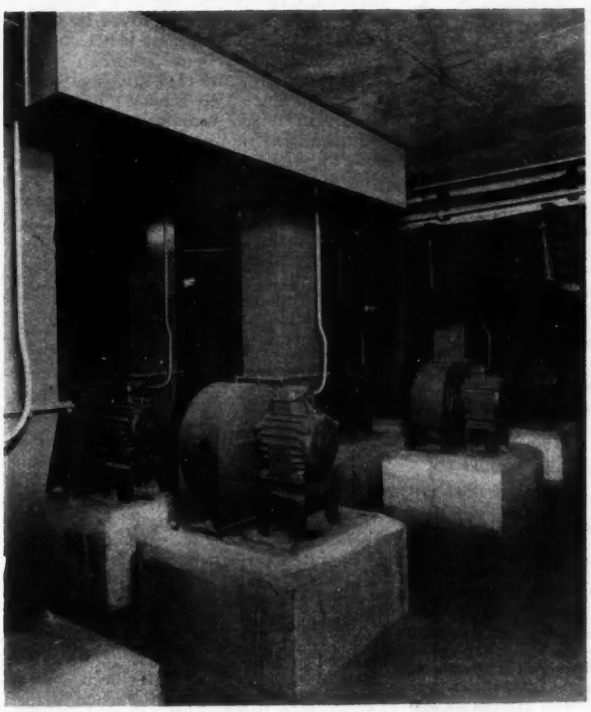
An Unusual Mercury-Arc Rectifier Installation

A mercury-arc rectifier installation, recently carried out by the General Electric Company, Ltd., in a chemical works in north-west England, embodies some novel departures from the company's standard design. For general industrial use the company has developed a standard cubicle, the upper part of which contains the pumpless air-cooled steel tank rectifier, while the lower part houses all the auxiliary apparatus.

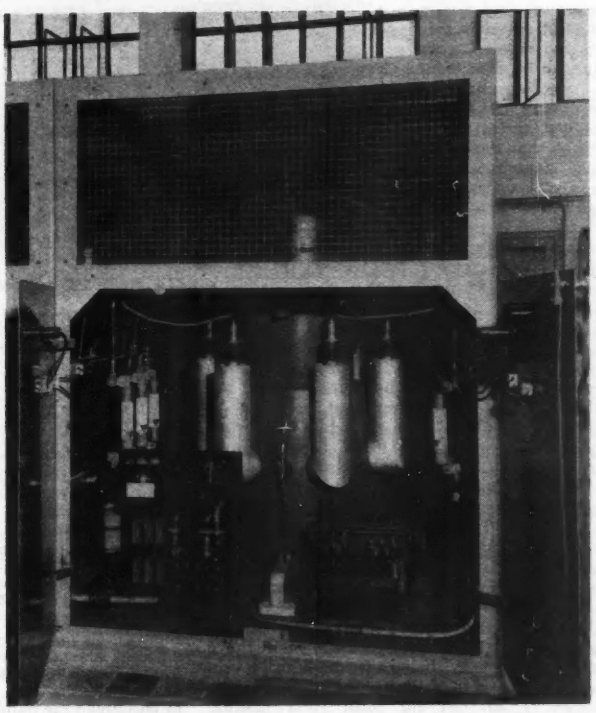
Although this standard design of cubicle is being used in extensions to the installation that we are considering, at the time of laying down the first section of the plant a combination of special requirements led to a different arrangement of the converting equipment, as illustrated herewith. The apparatus, consisting of four twin-cylinder, 500V, heavy current rectifier equipments, each rated at 625kW, was to be installed in the control room of the power house. It was necessary, however, that it should be possible to obtain an uninterrupted view over the plant from the control room floor and, further, that adequate circulation of dust-free air through the control room should be maintained. In addition, it was desirable that everything possible should be done to enhance the appearance of the control room, in which operators carry out normal supervision of the rest of the plant, although the rectifiers themselves need not be attended.

To meet these demands, the building was designed with a large basement, in which the rectifier auxiliaries could be mounted directly underneath the rectifier cylinders themselves. The busbars and cable runs are also accommodated in the basement, an arrangement which enhances the appearance of the control room. They are suspended from the underside of the control room floor, as shown in our first illustration, the main cable runs being passed through the walls of the basement to the rectifier transformers, which are housed in screened, brickwork enclosures at basement level.

Cooling air for the rectifier cylinders is drawn from the spacious basement, where air velocities are low and undesirable dust has an opportunity to settle. As a further precaution against the circulation of dust-laden air, the cooling fans are mounted on concrete plinths,



Ventilating Fans for Rectifier Installation



Rectifier Cylinder and Auxiliary Equipment

making the fan intakes about 2ft above floor level. The cooling air is fed through trunking to the underside of the rectifiers, mounted at floor level in the control room above, as shown in the second illustration, and is discharged over the cylinders, serving to maintain the control room at a slight excess air pressure.

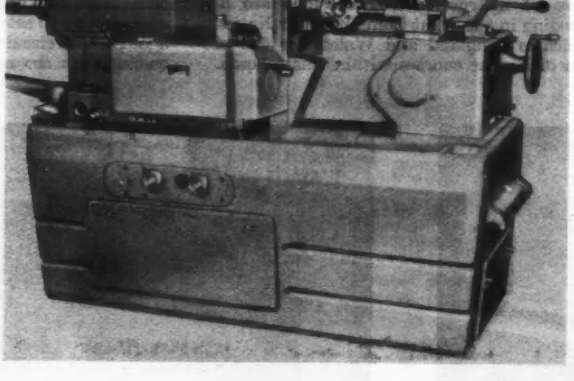
The rectifiers are arranged in two groups, each group comprising two pairs of cylinders. This arrangement permits an uninterrupted view to be obtained over the whole of the control room and the appearance is pleasing. The lower sections of the walls of the rectifier enclosures are of sheet metal, the upper portions and covers being wire mesh. This form of enclosure gives full protection against accidental contact with the rectifier tanks, which are, of course, alive at the full d.c. potential. Access to the rectifiers is provided by sheet metal doors, which are fitted with neat handles with integral locks, ammeters and ignition warning lights being mounted on the doors. A concrete moulding around the base of the enclosures protects the paintwork from damage.

Apart from the unusual layout of the apparatus, the installation is also of considerable technical interest because of the fact that the rectifiers are operating directly in parallel with a d.c. generator driven by a back-pressure steam turbine. The regulation of the respective equipments is so arranged that accurate load sharing is achieved. We learn that this installation has now been in service for several months with satisfactory results.

Single-Spindle Automatics

A REDESIGNED single-spindle automatic, known as the "L" type, is now being made in three sizes by B.S.A. Tools, Ltd., of Birmingham. Two versions, with maximum capacities for 1¼in diameter and 1⅝in diameter are made with long and short-stroke turrets, and a third of 2in capacity with a long-stroke turret only. The machines with long-stroke turrets have two automatic changes of speeds in forward and reverse, or a total of four spindle speeds in one cycle. The short-stroke turret machines have one automatic change of speed in forward and reverse.

As can be seen from the photograph we reproduce, the new machine has an open front, so that the swarf drops straight down into the tray, an arrangement which keeps the working parts free from obstruction, particularly when heavy stock removal is necessary.



SINGLE-SPINDLE AUTOMATIC

A wide range of speeds and ratios in forward and reverse directions are obtained by means of pick-off gears, accessible through a large door in the gearbox. The front end of the work spindle on the smallest machine is mounted on roller bearings, while the work spindles of the others have taper bronze bearings with fine adjustment for taking up wear. The thrust of the spindle is taken by opposed angular contact bearings at the rear end. The spindle drive is transmitted through two cone clutches and duplex roller chains from the gearbox. Jockey sprockets, controlled by two knobs on the front of the machine, ensure the correct chain tension.

The totally enclosed backshaft is driven at a constant speed by a belt from the main drive shaft, engagement being through a lever-operated clutch. Tripping of the various clutches is effected by push rods passing through the body of the machine. An overload device knocks out the backshaft starting clutch, and when a transfer unit is used any obstruction of the transfer arm serves to operate the knockout device. The cross slideways are of ample proportions, and adjustment is provided for setting forwards or backwards relative to the spindle. A vertical slide can be fitted when required, and all three slides are operated by cams.

The cross slides, stockfeed, spindle speed change and reversal and turret cam drives are all controlled by the front and turret camshafts. These mechanisms are easily accessible through hinged covers and they are driven from the backshaft through a worm drive and pick-off gears, providing 106 different cycle times which are entirely independent of spindle speeds.

The turret, which has six tool stations, moves on large square ways which have a taper gib to take up wear, and its slide feed is actuated by a cam-operated quadrant and rack. Smooth and rapid turret indexing is given by a link and Geneva motion indexing mechanism.

A positive-feed pump supplies lubricant to the work spindle bearings and cross slides. The gearbox bearings, chains and gears are lubricated by a circulating pump, oil being drawn from a sump in the base of the machine, passed through the bearings, &c., filtered and returned to the pump. All other bearings are lubricated either by a "one-shot" pump fed from the tank of clean oil, or by separate oil wells.

An ample supply of a filtered coolant at a constant pressure is maintained by coolant pumps and fittings which are included as standard on all machines.

The bar feed and collet opening mechanism is actuated by trip dogs controlled by a trip drum on the front shaft. Adjustment of the lengths of bar feed is provided up to a maximum of 4in on the long stroke and 2½in on the short stroke machines. All moving parts of the machine, other than the work spindle, are automatically stopped, when the end of the bar stock is reached, by a device which disengages the backshaft.

Two adjustable trip dogs on the front camshaft operate the work chute which separates swarf from the work, and the timing of opening and closing can be varied without the use of special cams.

WELDED BRIDGES COMPETITION.—The results of the recent international competition held by the James F. Lincoln Arc Welding Foundation for the design of an all-welded 250ft highway bridge, have been sent to us by the Lincoln Electric Company, Ltd., Welwyn Garden City, Herts. The competition attracted designers from sixteen different countries, the winner of the first prize of 5000 dollars being James H. Jennison, of Pasadena, California. The idea behind the competition was to encourage the building of better bridges for less cost and with less steel.

French Engineering News

(From our French Correspondent)

Modernisation of the briquetting plant in the Nord and Pas-de-Calais basin is nearing completion. At Rouen, which is the most important coal centre in France, a modern briquetting plant of the Société Rouennaise d'Agglomération has recently been inaugurated which is claimed to be a model of its kind. The plant has an hourly production capacity of 60 tons of briquettes. Small coal is received by sea and rail and stocked; it is then cleaned and graded into different qualities, and then dried in a vertical, revolving oven. It is then screened and large pieces are sent to a crusher. The screened coal is then stocked for dosage by the volumetric method. The products, after dosage, are mixed in a double-blade mixer. They then pass to two production groups, each consisting of a mixer, a worm screw and a 30 tons per hour briquette press. The briquettes are then loaded direct on to trucks or lorries.

* * *

Public works equipment provides one of the most spectacular exhibits at this year's Paris Fair. The equipment includes a 65m crane with a lifting capacity of 15 tons, and a variety of heavy plant, such as excavators, bulldozers, &c. There is a special section reserved for reinforced concrete and brick construction. Another section shows railway maintenance material, road machinery, and motors and pumps of all kinds.

* * *

A new cargo ship, the "Mont-Viso," has recently been launched at Grand-Quevilly by the Sté. Générale des transports maritimes. This 8000-ton vessel has two geared turbines giving a speed of 13·5 knots, and is equipped with lifting plant to enable it to load and unload its cargo. It will serve as a liaison with the Antilles.

* * *

E.C.A. has approved supplementary credits amounting to 6,322,000 dollars for purchases by France. The authorisations include 2037 dollars for industrial machinery, 1,875,000 dollars for chemical products and preparations, 340,000 dollars for industrial chemical productions, 235,000 dollars for construction, mining and transport material, and 153,000 dollars for electrical apparatus.

* * *

The agreement, in principle, between France and Italy, for the driving of a tunnel beneath Mont Blanc, has been approved by the French Cabinet. The plan is now being studied by a Franco-Italo-Swiss commission.

The tunnel will be 11·7 km long, with a roadway 7m wide. Two schemes have been proposed, in which cars will run through the tunnel, either under their own power, or on a railway truck. It has been shown, however, that there is no undue difficulty in providing adequate ventilation, so that cars could run normally through the tunnel. The cost of the work is estimated at 6500 million francs, of which three-eighths would be covered by the company holding the concession, and the rest by the States and organisations interested. Amortisation would be assured by a toll at the tunnel entrance.

* * *

French deliveries of rolling stock in fulfilment of foreign orders will consist in 1951 of the first of ninety locomotives for Brazil, ten steam locomotives for Rhodesia, fifteen autorails for Greece, ten passenger coaches for Luxembourg, and 235 passenger coaches for Pakistan. Finally, India is to receive 3160 trucks on which delivery has started. The Sté. Inter-Frigo, a company using international refrigerated transport, has ordered 175 trucks.

French industry has also been prominent in providing equipment for the sugar industry. A French firm has completed a factory treating 1200 tons of sugar daily in Uruguay; at Ankaratra (Madagascar) a factory crushing 2500 tons of cane daily has been constructed, and in Spain and Brazil French industry is installing sugar refining plants.

Industrial and Labour Notes

The T.U.C.'s Taxation Proposals

The Trades Union Congress has published a summary of the proposals which it has recently submitted as evidence to the Royal Commission on Taxation of Profits and Income. It says that in framing these proposals particular attention was given to the question of incentives, risk-bearing, savings, the control of inflationary and deflationary tendencies, and the effect on the distribution of personal incomes.

The general council of the T.U.C. believes that the disincentive effects of the operation of P.A.Y.E. have been exaggerated and do not justify the introduction of special rates of tax for income derived from overtime and extra effort. It suggests, however, that there is a case for a smoother gradation of taxation up to the point at which the standard rate applies, and it thinks that more should be done to let taxpayers know how P.A.Y.E. works and how it affects them. The general council does not agree with the suggestion that the redistribution of incomes has gone too far and should be reversed. It does recognise, however, that on the whole redistribution through the taxation of incomes has gone about as far as is practicable, and that there is little possibility of making much further progress "along the lines followed up to now." But it nevertheless considers that the rate of progression on higher unearned incomes should be increased. The T.U.C. statement goes on to say that the importance of direct taxation as an instrument for controlling inflationary or deflationary tendencies lies in its effect on incomes rather than its effect on prices. Direct taxation is not the most effective instrument for reversing short-term inflationary or deflationary trends, but, the statement says, it can and should be used for controlling long-term tendencies towards inflation or deflation.

The comment on "risk-bearing" is that, other things being equal, a high and progressive rate of taxation will reduce the willingness and ability of individuals and corporations to invest at risk, but the T.U.C. asserts that the use of the resulting revenue by the Government to promote full employment and the consequent reduction in the risk of investment generally must also be taken into account. According to the T.U.C., the available evidence does not suggest that there has yet been a marked shortage of risk capital for enterprise. It admits the possibility, however, that continuing high taxation will reduce the proportionate amount of savings forthcoming from private individuals and companies for risk investment, and the general council therefore considers that the Government could and should undertake to provide risk capital where necessary.

Distribution of Magnesium

The Minister of Supply has made the Magnesium Distribution Order, 1951 (S.I. 1951, No. 891), which will come into force on June 11th, and which provides that any person proposing to acquire, treat, use or consume virgin magnesium and virgin magnesium alloys must have a licence. This licensing system has become necessary, it is stated, because defence needs will take nearly all the available supplies of magnesium for some time to come.

The Ministry of Supply says that the steps which have been taken to increase supplies include long-term contracts with overseas suppliers and the reopening of magnesium plants in this country which were operating during the war. Production from these reopened plants will begin in July and is to be expanded as quickly as possible to meet the rising demand. Under the new Order, the need for a licence to treat, use or consume relates not only to metal acquired on and after June 11th, but also to stocks held at that date. Applications for licences must be made to the Ministry of Supply (M2*b*), Shell Mex House, London, W.C.2. The Ministry will continue to require monthly returns of metal stocks and of estimated future consumption of magnesium. In addition, it will require monthly returns showing past consumption and the purposes for which the metal has been used.

The Price of Copper

The Ministry of Supply has announced that, as from May 25th, the price of electrolytic copper has been increased from £210 to £234 per long ton delivered to consumers' works. Discounts and the forward purchasing arrangements announced on May 1st remain unchanged. From the same date, the Ministry's buying price for rough copper, in slabs of from 2 cwt to 3 cwt, has been increased from £170 to £180 a ton. The new selling price for electrolytic copper has been determined in view of the higher price recently fixed in the U.S.A. At the beginning of the year copper was £202 a ton, and on January 1, 1950, the price was £153 a ton.

The Regional Boards for Industry

A booklet has been issued this week setting out the constitution and the principal functions of the Regional Boards for Industry, which were established in this country as Area Boards during the war, and have been continued in the post-war years as advisory rather than executive bodies to provide a means of co-operation between employers, trade unionists and Government officials in dealing with the special problems of industry. There are eleven of these boards, their independent chairmen, who give part-time service, being appointed by the Chancellor of the Exchequer. The chairmen are assisted by two vice-chairmen, one from each side of industry, who are appointed from the membership of the boards. The industrial membership of each board consists of ten—or sometimes twelve—representatives, equally divided between employers and trade unionists, who give their services without remuneration. They do not represent any particular firm or organisation, and can therefore speak for industry as a whole without the need to refer to any parent body. Senior regional representatives of several Government departments are also full members of the boards.

The Regional Boards advise Ministers and their departments upon industrial conditions within their regions and upon steps which may be necessary to bring regional resources into fuller use. They keep in touch with the work of Government departments in the regions and represent the needs of industry to local authorities. The Boards also advise local industry of Government policy in relation to industry, and vice versa, are in a position to communicate to Government departments the views of industry in the regions. They are, in addition, called upon to deal with any other matters affecting production which may be referred to them as suitable for local treatment, although wages and conditions of employment are outside their terms of reference. The booklet says that the Regional Boards consider a wide variety of matters ranging from shortages of labour and raw materials or components to the effects of national service and territorial training on industry. In a number of cases, it is claimed, recommendations made by the boards have resulted in a modification of national policy. The view is expressed that the boards provide an opportunity for collaboration and co-operation between Government, employers and workpeople in a way not previously possible in the industrial affairs of this country. They are readily accessible bodies to which local organisations of employers and workpeople can make suggestions or complaints on production matters.

The booklet, which can be obtained from the Regional Boards, will certainly be useful to industrialists who may not find it easy to determine the functions of the many committees and other organisations which are now concerned in some way or another with their day-to-day activities.

Steel Production Prospects

The British Iron and Steel Federation has included in the latest issue of its *Monthly Statistical Bulletin* some observations on steel production prospects in Great Britain during the current year, together with an explanation of some of the problems with which the iron and steel industry is attempting to grapple at the present time. It says that the achievement of last year's record output of 16,293,000 tons of steel ingots and castings was materially assisted by the large quantities of German scrap which the industry has been able to secure during the past two years. But it is now generally known, of course, that the raw materials position—for steel, as for other industries—has suffered a marked deterioration in recent months. With the drying up of German supplies, the industry may be unable to obtain more than 500,000 to 600,000 tons of imported scrap this year, compared with almost 1,900,000 tons in 1950. The supply from Germany, it is stated, seems likely to be about half that embodied in the German trade agreement for 1951, which was made last autumn.

Imported iron ore is also likely to prove difficult. Contracts have been placed for 9,300,000 tons, but in view of severe shipping difficulties—mainly because of Western Europe's need to import coal from the U.S.A.—it may prove impossible to bring in more than 8,600,000 tons of ore this year. Making some allowance for the rebuilding of iron ore stocks, consumption of imported ore in blast-furnaces may fall slightly from 8,678,000 tons in 1950 to 8,400,000 tons this year. But, the Federation points out, against this limitation on imported ore supplies, there should be a substantially increased usage of home ore—from 12,777,000 tons to 14,300,000 tons—if the necessary coke is available. Despite the loss of imports, the industry is thus hoping to expand its total pig iron and ferro-alloy production from 9,633,000 tons in 1950 to 9,735,000 tons this year. Allowing for a small import and some reduction in pig iron stocks to about the 1948 level, this would enable the consumption of steel-making pig iron to rise from 7,435,000 tons to 7,890,000 tons this year. British steel-making prospects will also be governed this year by the success of the industry's campaign to obtain more scrap from home sources. But, the Federation says, it cannot be expected to provide a "bonus" large enough to offset more than part of the heavy prospective drop in imports. It is thought reasonable to allow for a reduction in steel-makers' stocks of scrap to the mid-1948 level. Even so, scrap consumption in steel-making may not greatly exceed 9,500,000 tons as compared with 10,250,000 tons last year.

The developments in the raw materials position, the Federation considers, should enable British steel production to be maintained at the rate of 16,000,000 tons a year in 1951–52, as envisaged in the industry's original development plan, and the annual rate of 18,000,000 tons to be reached by about 1954–55. It is, of course, the sudden change in the imported scrap and ore position which makes it necessary to draw on stocks of steel-making materials. But these had been built up very substantially from the 1947–48 level by the beginning of last autumn so that the industry had a margin in hand. The immediate need is to secure the production of steel at an annual rate of 16,000,000 tons without any further reduction of raw material stocks. In the short term, it should be added, the imported ore position—which is as vital as the use of more home ore—depends almost entirely on securing the necessary shipping, and on any help that might be secured if the U.S.A. reduced her calls on raw materials from European sources.

Notes and Memoranda

Rail and Road

INSTITUTION OF CIVIL ENGINEERS.—Mr. Allan S. Quartermaine, C.B.E., M.I.C.E., has been elected to succeed Dr. W. H. Glanville as President of the Institution of Civil Engineers. He will take office in November. Mr. Quartermaine is chief engineer on the Western Region of British Railways, and is a Fellow and Chadwick Scholar of University College, London.

ROAD PASSENGER TRANSPORT SERVICES.—The Summary of Annual Reports of Road Licensing Authorities states that the number of passenger journeys on all buses and coaches owned by operators of more than five vehicles, except London Transport Executive, was 9924 million during their financial years which ended between April 1, 1949, and March 31, 1950, compared with 9400 million for 1948–49. This is an increase of 5·6 per cent. The vehicle mileage performed rose by 7·4 per cent from 1591 million miles in 1948–49 to 1708 million in 1949–50, but the total net receipts decreased by 13·3 per cent as compared with the preceding year. The total number of vehicles owned by these operators increased by 8½ per cent during the year.

PASSENGER TRANSPORT SCHEME FOR S.W. AREA.—The British Transport Commission proposes to consider the preparation of a passenger road transport scheme for the south-western area, comprising the counties of Cornwall and Devon and the portions of Somerset and Dorset which lie to the west of a line drawn approximately from Burnham-on-Sea through Glastonbury, Wells, Frome, Shaftesbury and Blandford to Studland. The area would be divided into districts to facilitate efficient control of the services. The Commission already controls two of the largest passenger road transport undertakings now operating in this area. Before forming any conclusions as to the form which a scheme for this area should take, the Commission and its Road Passenger Executive are asking the county councils and county borough councils concerned to submit any representations which they may desire to make.

Air and Water

MILITARY FLYING BOATS.—Flying boats to replace the Short "Sunderland" and fitted with turbo-propeller engines, are now in the design stage. The "Sunderland" flying boat was designed fifteen years ago, and those at present engaged in Korea have an average age of eight years. Trials also continue with the single-engined turbo-jet fighter, "SR/A1," made by Saunders-Roe, Ltd.

NORTH ATLANTIC PLANNING BOARD FOR OCEAN SHIPPING.—In accordance with its directive from the North Atlantic Council, the North Atlantic Planning Board for Ocean Shipping has agreed on an outline plan for the mobilisation of ocean-going shipping in a single pool and its allocation on a world-wide basis in time of war or wartime emergency, and for the establishment in such circumstances of an international organisation of a civilian character to be named the Defence Shipping Authority. The object of the Defence Shipping Authority would be to ensure that shipping is so organised as to achieve the greatest possible economy in its employment and to render it effectively and readily available to meet the needs, both military and civil, of the co-operating nations according to approved priorities.

Miscellanea

GROUND SULPHUR PRICE INCREASE.—The Board of Trade has made an Order, with effect from June 1st, permitting increases in the maximum prices of all grades of ground sulphur. These increases of approximately 30 per cent result mainly from the rise in freight rates since the beginning of the year.

TRAINING FOR SCIENCE TEACHERS.—The Massachusetts Institute of Technology and Harvard University have announced plans for a joint five-year programme for the training of science and mathematics teachers. The training is designed to equip young men and women for teaching in high schools and junior colleges, the course leading to the degrees of B.Sc. in general science at Massachusetts and M.A. in teaching at Harvard.

WATER POLLUTION PREVENTION.—Engineers and research workers from South Africa, Italy, France, Austria, Finland and Belgium assembled in London on May 21st for a fortnight's course on water pollution prevention arranged by the British Council. A number of sewage treatment works, laboratories and plants for disposal of industrial effluents are being visited by the party, the course concluding with a discussion at the Water Pollution Research Laboratory, Watford.

THE LATE DR. D. F. TWISS.—We have learned with regret of the death, on May 23rd, of Dr. D. F. Twiss, who, until his retirement in 1946, was for thirty-two years chief chemist of the Dunlop organisation. He was sixty-eight. During his career Dr. Twiss took out about 200 patents, mostly for new processes or new uses of rubber. In 1934 the Institution of the Rubber Industry awarded him the Colwyn Gold Medal for his scientific contributions to the knowledge of rubber.

THE BRITISH STANDARDS INSTITUTION.—The British Standards Institution, which celebrates its golden jubilee this year, has stated that fifty separate industries will participate in the special exhibition which is being arranged at the Science Museum, South Kensington, from June 18th to 28th. The Institution says that the response from national trade associations, national boards and Government departments has been so considerable that the space occupied by the exhibition will now be about 15,000 square feet. The jubilee programme includes a conversazione to be held at the Natural History Museum, South Kensington, on Friday, June 22nd, at 7.30 p.m., which will be attended by the Presidents and Directors of twenty-six overseas standards bodies.

CONFERENCE ON MIXING AND AGITATION IN LIQUID MEDIA.—The Institution of Chemical Engineers announces that it is holding a conference on "Mixing and Agitation in Liquid Media" at the Royal Institution on July 17th next. In the course of the conference the following papers will be presented in abstract and discussed:—"Recent Developments in the Theory and Practice of Agitating and Mixing," by Dr. D. M. Newitt, Mr. G. C. Shipp, and Dr. C. R. Black; "The Mixing of Coal with Liquids," by Mr. R. A. A. Taylor; "Practical Aspects of Liquid Mixing and Agitation," by Mr. Brian N. Reavell; "Liquid-Liquid Mixing as Affected by Internal Circulation Within Droplets," by Dr. F. H. Garner and Mr. A. H. P. Skelland; "The Action of Free Jets in the Mixing of Fluids," by Mr. H. Fossett; and "Some Factors Affecting Mixing Processes in the Ceramic Industry," by Dr. A. E. Dodd and Mr. F. J. Goodson.

COURSE ON ELECTRONICS AT HARWELL.—Physicists and engineers who desire specialised knowledge of electronic instruments used in nuclear physics, radio chemistry and work with radio isotopes, are being offered a course at the Atomic Energy Research Establishment, Harwell. It will last from Monday, July 23rd, to Friday, July 27th, and will deal specifically with the use of electronic equipment for detection and measurement of radiation, the mornings being devoted to lectures and the afternoons to practical work. Design, use and maintenance of counters, d.c. pulse amplifiers, kick sorters, scalers and registers, and automatic equipment will be included in the syllabus. Lecturers and demonstrators will be specialists from the A.E.R.E. Candidates for this course are limited to twelve and will be expected to have a background knowledge equivalent to degree standard in physics or electronics. The fee for the course is twelve guineas. Living accommodation (at Buckland House, near Faringdon, one of the A.E.R.E. senior staff hostels), transport and morning and evening meals will be provided at a charge of five guineas. Application should be made to the Electronics Division, A.E.R.E., Harwell, Didcot, Berks.

A FILM ON SOLDER.—On Tuesday last there was shown in London a new sound film entitled "The Vital Link," which has been made by H. J. Enthoven and Sons, Ltd., of 230, Thornton Road, West Croydon, Surrey. It describes in detail the manufacture, properties and uses of the firm's "Superspeed" cored solder. The film is in colour and, with its excellent commentary, is a good example of informative technical publicity, which will be appreciated by both technical and non-technical audiences. In the "Superspeed" solder described in the film the non-corrosive chemically activated rosin-based flux core is arranged with six flutes radiating from a central core to a point near the periphery. As part of the flux core is located near to the outside surface of the solder, the heat penetrates very quickly and gives a rapid liberation of the flux to speed the soldering process. The film, in addition to showing the way in which soldering of many types of joints is accelerated when using the improved solder, described the raw materials used, the close control exercised at all points in manufacture, and the methods of manufacture in the company's works. Copies of the film will be lent by the firm to interested societies and educational bodies.

EUROPEAN PURCHASING COMMISSION.—The Ministry of Supply has announced the opening of two of the four main European offices of the newly-formed European Purchasing Commission. The directors of these offices and their addresses are Mr. Norman W. Doley, 107, Rue Belliard, Brussels, and Mr. A. S. Radford, 5, Mehlemer Strasse, Marienburg, Cologne. The addresses of other offices at Paris and Milan and the names of directors will be announced later.

SUMMER SCHOOL IN AUTOMATIC COMPUTING.—A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory, Cambridge, from September 11th to 21st. It will be along the same lines as one held last year. It is now widely recognised that these computing machines can make a large contribution towards the solution of a variety of problems in mathematics, physics, engineering and other subjects. The course will give a basic training in the mathematical use of machines, dealing with the processes employed and their embodiment in programmes which specify the operation in detail. Lectures and practical classes will be held in the design of programmes for the "Edsac," the machine which has been built in the Laboratory. It will be shown how the same principles may be applied in designing programmes for other machines. A detailed syllabus and form of application for admission may be obtained from Mr. G. F. Hickson, M.A., secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

Personal and Business

MR. J. A. ARNOLD-FORSTER has been elected President of the Royal Institution of Chartered Surveyors.

MR. W. C. HANDLEY, M.I.E.E., has been appointed an executive director of British Insulated Callender's Cables, Ltd.

MR. JOHN H. LORD, an executive director of Dunlop, Ltd., has been elected President of the Federation of British Rubber Manufacturers' Associations.

A.C.E.C. announces that Land Speight and Co., Ltd., 73, Robertson Street, Glasgow, C.2, has been appointed exclusive distributor in Scotland for "Dictorel" machines.

LONDON TRANSPORT announces the appointment of Mr. C. T. Goodchild as works superintendent (Aldenham). He will be responsible for the general control of the Aldenham overhaul works.

FOLLSAIN-WYCLIFFE FOUNDRIES, Ltd., and Varatio-Strateline Gears, Ltd., announce that Mr. T. R. Taylor, 51, Netherpark Avenue, Netherlee, Glasgow, S.4, has been appointed their Scottish representative.

DOWDING AND DOLL, Ltd., Greycoat Street, London, S.W.1, informs us that it has accepted from Oerlikon Machine Tool Works Buehrle and Co., Zürich, the sole agency in Great Britain, Northern Ireland and Eire for its complete range of machine tools.

THE SOUTH-WESTERN ELECTRICITY BOARD states that Mr. L. V. Turner, M.I.E.E., has retired from the post of sub-area manager at Taunton. He has been in the electricity supply industry for forty years. His successor at Taunton is Mr. E. A. Newburn, M.I.E.E.

EVERSHED AND VIGNOLES, Ltd., Acton Lane Works, Chiswick, W.4, announces that Mr. G. B. Rolfe, M.I.E.E., has been appointed a director. Mr. Rolfe, who has just retired from the position of chief engineer, has been associated with the company for forty-three years.

CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., 232, Dawes Road, London, S.W.6, states that arrangements have been completed with the Duff Norton Manufacturing Company, Pittsburg, U.S.A., for the manufacture in this country of the 5-ton Duff Norton automatic lowering jack.

Contracts

THE FORD MOTOR COMPANY, Ltd., Dagenham, has received an order from the Turkish State Agricultural Buying Organisation for over 2300 "Fordson Major" tractors. The Organisation has already placed an order for 1150 of these tractors, and this latest order, together with smaller purchases in the meantime, brings the total since December to over 5000. The sum involved is approximately £3,000,000, which, in addition to the tractors, covers "Fordson" implements and spare parts.

British Patent Specifications

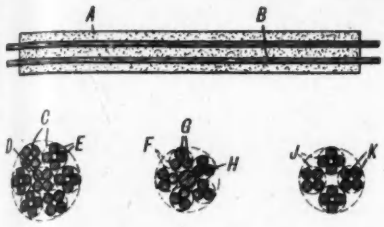
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

STRUCTURAL ENGINEERING

652,585. November 12, 1948.—STEEL REINFORCING CABLES FOR PRESTRESSED CONCRETE ELEMENTS, N.V. Schokindustrie, of Lindtschedijk 2b, Zwijndrecht, The Netherlands.

The invention consists of a composite steel reinforcing cable for use in prestressed concrete elements. This cable is composed of at most six separate strands, twisted around the axis and each composed of at most four twisted solid steel wires. Referring to the upper drawing, *A* is a concrete beam provided with longitudinal, tensioned, reinforcing cables *B*, constructed according to the invention. In the first construction shown below



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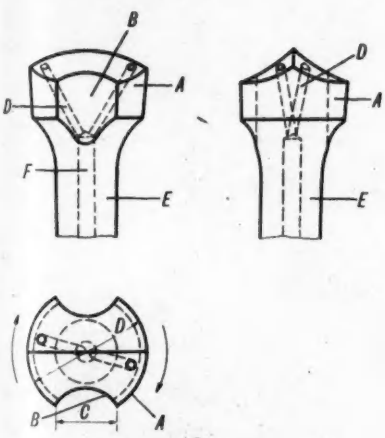
the cable *B* is composed of six strands *C* twisted about a core *D*, the strands and core each consisting of four twisted steel wires *E*. In the centre view the cable is composed of five strands *F*, each of which is composed of three twisted steel wires *G*, the strands being themselves twisted or wound about a core *H* which consists of a solid steel wire having a diameter greater than the wires forming the twisted strands *F*. In the third section the cable is composed of four strands *J*, each of which is composed of four steel wires *K*. In this embodiment a core wire is not necessary.—*April* 25, 1951.

WORKSHOP TOOLS AND APPLIANCES

652,562. September 30, 1948.—ROCK BORING HEAD FOR PERCUSSIVE BORING, Gebr. Bohler and Co. Aktiengesellschaft, of Elisabethstrasse 12, Vienna, I, Austria.

For the percussive boring of rock, simple chisel cutting edges have been extensively employed owing to the ease of subsequent sharpening. In this invention the head of the borer, instead of being flat, is formed slightly conical and the



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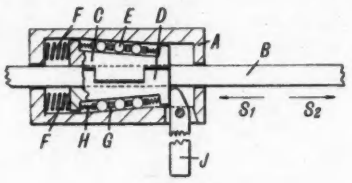
surface wall of the cone, acting as means of guiding the borer, is only interrupted by narrow flushing grooves, the combined width of which does not amount to more than one-third of the circumference of the borer head. Referring to the drawings, the slightly conical wall surface *A* of the boring head is interrupted by two flushing grooves *B*, the sum of the widths *C* being equal to or less than one-third of the circumference of the boring head. Two bores *D* are connected to the conduit *F* for the flushing medium which passes through the shank *E*, the bores opening out at the flanks of the cutting edge, in the direction of rotation of the borer, in proximity to the front of the cutting edge. The direction of rotation is indicated by arrows. The flank surfaces of the cutting edge are convex parallel to the cutting edge, and concave perpendicular to the cutting edge. The cutting edge can also be formed by a hard metal plate inserted in the boring head.—*April* 25, 1951.

652,546. August 24, 1948.—DEVICE FOR RESTRAINING RETURN MOTION, Vitkovicke Zelezarny, narodni podnik, of Ostrava 10, Czechoslovakia; and Miroslav Koun, of Ostrava-Marianske Hory, Prazakova, 14, Czechoslovakia.

The device according to the invention for restraining return motion is designed for braking the back thrust in machines and objects which move on or along a guide. As shown in the drawing, the device consists of a housing *A*, through which a guide *B*, such as a rod, a cable, or a chain, passes and receives the forces produced by the restraining device. The housing is connected to the apparatus or machine, in which the back thrust is to be prevented. The wedge cheeks *C* and *D* grip the guide through the balls or rollers *E*. When the cheeks are forced into engagement with the wedge surfaces of the housing by the pressure of springs *F* the grip-



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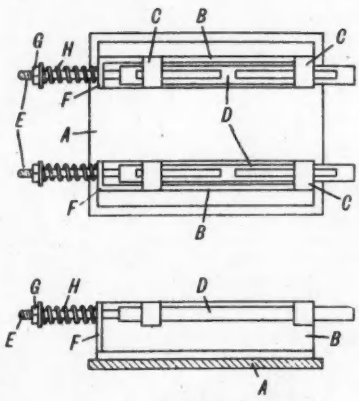
ping pressure produced causes the guide *B* to hold fast against displacement, by the friction set up. Even with a small return movement of the body *A* in the direction S_1 the clamping effect on the guiding device is increased to a degree which in each case depends on the inclination of the wedge surfaces, and the body is held to the guide by the friction set up. The rollers are retained in their mean position by a suitable guide frame *G* and springs *H*. When the housing moves in the opposite direction S_2 the force of the spring *F* must then be directly overcome, since the wedge surfaces move apart. The cheeks automatically follow the housing in its movement in direction S_2 because of the spring action, and are always ready for restraining the return movement. In order that the housing can readily be shifted in the direction S_1, the action of the wedge surfaces is eliminated by forcing the cheeks back against the action of springs *F* with the aid of a lever *J*, which is pivoted in the housing. —*April* 25, 1951.

POWER TRANSMISSION

652,525. December 7, 1948.—BELT TENSION CONTROL FOR MOTORS DRIVING MACHINERY, Poul Gerhard Christensen, of Hadsundvej 78, Vejgaard, near Aalborg, Denmark.

As the accompanying drawings show, a foundation plate *A*, is arranged with a foot *B* at each side, with bearing supports *C*, in which a rail *D* is movably mounted, having in its longitudinal



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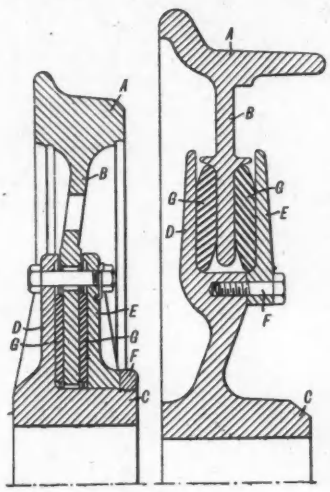
direction slots for receiving the mounting bolts for the motor. Extending from one end of the rail is a rod *E* passing through a hole in an end piece *F* of the foot. Round the rod is arranged a compression spring *H*, which can be controlled by means of a nut *G* on the rod. The two feet *B* are spaced apart at an adjustable distance from each other and each secured to the foundation plate by means of bolts, so that the distance between them can be adjusted according to the width of the motor. By means of the nut the spring is initially compressed to provide a desired tensioning of the motor belt. When the belt contracts the rails (with the motor) slide in the bearings, so that the spring is compressed. On the other hand, when the belt tension is released the spring expands and pulls the rails with the motor the opposite way to maintain reasonable belt tension.—*April* 25, 1951.

RAILWAY ENGINEERING

652,909. September 25, 1948—RESILIENT WHEELS, Dunlop Rubber Company, Ltd., of 1, Albany Street, London, N.W.1; and Geoffrey William Trobridge, Robert Maxwell Seddon and Paul Brierley, of the company's works at Fort Dunlop, Erdington, Birmingham, 24.

Referring to the accompanying drawings, in the left-hand view the wheel comprises a rim *A* integral with an inwardly-directed annular flange *B* and a hub *C* having an annular channel formed by an annular flange *D* integral with the hub and another flange *E* secured by a locking collar *F* and twelve bolts. The flange *B* is fixed in the annular channel



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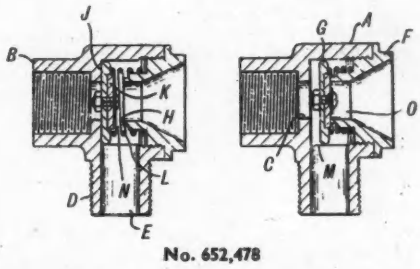
by rubber rings *G* held under compression between adjacent faces of the rim flange and the hub flanges. The hub flanges have inwardly projecting peripheral portions adapted to engage with projecting portions on the rim flange and act as safety stops if the side thrust exceeds a predetermined value, as may occur if a train takes a curve at a high speed. The modified design, illustrated to the right, has a similar construction and comprises a rim *A* having a flange *B*, a hub *C* with integral and detachable flange *D* and *E*, the detachable flange in this embodiment being secured to the hub by bolts *F* only. The rubber rings *G* are bevelled on opposite sides so as to provide clearance between the faces and the adjacent faces of the rim and hub flanges. Annular projections on the rim flange act as safety stops.—*May* 2, 1951.

VALVES

652,478. May 27, 1948.—EXHAUST VALVE FOR AIR PRESSURE SYSTEMS, Arthur Croft, of Buckstone Hall, Rawdon, near Leeds.

This invention relates to quick-opening exhaust valves employed in air pressure systems, such as those used in controlling clutches, brakes, machines



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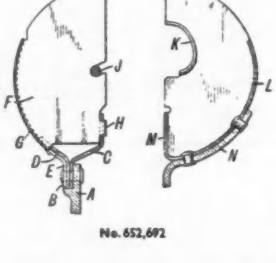
or other devices or apparatus, for exhausting air from the latter when the feed air pressure is cut off. In the accompanying drawing the left-hand view is a sectional elevation of a valve in the open air inlet position, while to the right hand is a similar view showing the valve in the exhausting position. The exhaust valve comprises a hollow body *A* with

an inlet boss *B* projecting from the inlet *C* for connection to the feed pressure pipe. A boss *D* at right angles forms the outlet *E* for the feed pressure. A valve seating element *F* is mounted in the body of the valve in alignment with the feed inlet and a plate valve closure member *G* is a neat sliding fit between the seating *H* of the seating element and the end facing *J* of the valve chamber through which the feed inlet communicates with the valve chamber. The disc valve may be of metal with a rubber or other material seating washer *K* secured to its rear face. A coiled spring *L* is carried by the seating element to press the disc valve member normally against the facing *J*. When the valve member is against the facing then the inlet port *M* is closed, the whole of the chamber then having communication with the outlet *E*, and an exhaust port *N* is formed between the chamber and exhaust outlet *O*. Modified constructions are also shown in the specification.—*April* 25, 1951.

HYDRAULIC ENGINEERING

652,692. December 6, 1944.—HYDRAULIC TORQUE TRANSMITTING DEVICES, Arthur Harold Stevens, of Stevens, Langner, Parry and Rollinson, Chartered Patent Agents, of 5–9, Quality Court, Chancery Lane, London, W.C.2 (*communication from Borg-Warner Corporation, of* 310, *South Michigan Avenue, Chicago, U.S.A.*).

This invention is concerned with hydraulic torque transmitting devices, and particularly with vaned hydraulic couplings. One of its objects is to provide an improved fluid coupling which is light and cheap to make, and which incorporates a mechanical shock-absorbing function to eliminate vibration and shocks during low slip conditions. As shown in the left-hand drawing, a hub member *A* is formed with a shoulder *B* which centres a pair of diverging discs *C D*, as well as an attaching sector *E* of a vane *F*. A rivet secures all three of these elements to the hub. The vane is formed with an integral flange or rib *G*, which serves to



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stiffen the lower portion and to guide the fluid around that portion of its circuit. At its inner edge it is provided with tabs *H*, which are received in slots in the disc. Further support may be supplied by means of a wire hoop *J*, which may be slipped into a notch near the centre of the toroidal circuits. A modification of the support for the vanes is shown in the right-hand drawing, in which the vane has a core ring *K* formed integrally with it, and also a flange or rib *L* formed around a portion of the outer periphery. The flange *L* continues radially outwardly into the hydraulic circuit and forms a baffle *M*. The flange *L* may be riveted to a suitable hub member *N*, which is designed to possess sufficient rigidity to transmit the necessary torque without distortion. The vane is flexible and the flexibility may be controlled by choosing the proper length and size of flange.—*May* 2, 1951.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Chemical Council

Wed., June 6th.—Royal Institution, Albemarle Street, London, W.1, "Chemistry and Modern Thought," Sir Cyril Hinshelwood, 6 p.m.

Chemical Society

Thurs., June 7th.—Royal Institution, Albemarle Street, London, W.1, "A Chemotherapeutic Search in Retrospect," F. L. Rose, 7.30 p.m.

Incorporated Plant Engineers

Mon., June 4th.—LONDON BRANCH: Shell Mex House, Strand, London, W.C.2, Talk and Discussion on "Oil Refineries," 7 p.m., to be followed on June 5th by an all-day visit to Shellhaven.

Tues., June 12th.—E. LANCS BRANCH: Engineers' Club, Albert Square, Manchester, "Maintenance of Industrial Instruments," 7.15 p.m.

Institute of Industrial Administration

Wed., June 6th.—LONDON CENTRE: Fyvie Hall, The Polytechnic, Regent Street, London, W.1, "Cost Control," H. H. Norcross, 6.30 p.m.

Institute of Road Transport Engineers

Fri., June 8th.—S. WALES GROUP: Visit to the works of the Homerton Rubber Company, Ltd., Treforest Trading Estate, Glam, 7 p.m.

Institution of Civil Engineers

Fri., June 8th.—YORKSHIRE ASSOCIATION: Visit to Woodhead tunnel.

Joint Engineering Conference

Mon., June 4th to Fri., 15th.—Meetings at Institution of Civil Engineers, Great George Street, Westminster, S.W.1; Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1; and Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. For details of arrangements see THE ENGINEER, May 18th, page 662.

Junior Institution of Engineers

Thurs., June 7th.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Festival of Britain—Special Meeting to commemorate this event, 7 p.m.

Stoke-on-Trent Association of Engineers

Sat., June 2nd.—Midlands Electricity Board, Back Glebe Street, Stoke, Annual General Meeting.

Women's Engineering Society

Sat., June 2nd.—LONDON BRANCH: Visit to Festival of Britain, 1951.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

ELECTROPLATED COATINGS OF CADMIUM AND ZINC ON IRON AND STEEL

No. 1706 : 1951. This standard forms one of the series of British Standards which is being prepared, covering electroplated coatings. It deals specifically with protective coatings on electroplated articles. It does not cover coatings on sheet, strip or wire. The foreword points out that cadmium and zinc each have specialised fields of service and, therefore, the metal and class of coating should be chosen to suit the intended purpose. The committee preparing the standard realised that it was impossible at present to specify completely every factor affecting the performance of an electroplated coating but, in view of the urgent demand for some basis of comparison for such coatings, the standard is being published in its present form for the assistance of manufacturers and purchasers. The British Standard covers the essential qualities of the coatings in question, stipulating limits for the purity of the coating, the finish and appearance of the plated surface, the thickness and adhesion, together with appendices giving the methods of test. A section is also included dealing with the passivation of zinc coatings. Price 2s. 6d., post free.

AIR FILTERS FOR INTERNAL COMBUSTION ENGINES AND COMPRESSORS

No. 1701 : 1950. This specification relates to the general characteristics of air filters, their test performance and conditions and methods of testing. The first section is concerned with the type and construction of filters. The test performance is laid down in Section II which covers air flow, efficiency, pressure drop, dust-holding capacity and oil carry-over. Section III deals with condition and methods of testing for the determination of dust-retaining efficiencies, pressure drops and other characteristics. There are also nine appendices, which are mainly concerned with dust analysis. Price 4s. post free.

STEEL FURNACE TUBES

Nos. 1730 and 1731 : 1951. These two standards are included in the series which is being prepared for the petroleum industry. They are as follows :—

No. 1730. Seamless low carbon and carbon-molybdenum steel furnace tubes for the petroleum industry.

No. 1731. Seamless alloy steel furnace tubes for the petroleum industry.

The first-mentioned provides for one grade of low carbon and one grade of carbon-molybdenum steel furnace tubes, which have been based on the standard A.161 of the American Society for Testing Materials. It contains full chemical analysis as well as mechanical properties required of the tubes, together with tolerances and methods of test.

The other standard provides two grades of alloy steel furnace tubes, one being a 2¼ per cent chromium, 1 per cent molybdenum, and the other 5 per cent chromium, ½ per cent molybdenum steel, which have been based on the standard A.200 of the American Society for Testing Materials. It contains full chemical analysis as well as mechanical properties required of the tubes, together with tolerances and methods of test. Price 2s. each, post free.

CAST IRON ECONOMISERS WITH EXTENDED SURFACE HORIZONTAL TUBES

No. 1712 : 1951. This standard relates to cast iron economisers having extended surface horizontal tubes fitted with flanges and having a maximum water design pressure of up to and including 650 lb per square inch (gauge). It is concerned solely with non-steaming cast iron economisers. The primary purpose of this standard is to clarify the position regarding the permissible pressures and temperatures for cast iron economisers. The limitations given in this standard are based on experience with the use of cast iron economisers over many years. This standard lays down requirements for materials and workmanship. In the section dealing with construction, formulæ are included for determining the minimum thicknesses of economiser tubes with gills or other extended surfaces, connector bends and manifold pipes. Formulæ for determining flange dimensions and the number of bolts and studs to be used are also given. The minimum sizes of studs to be used for certain pressures are laid down and also the minimum length for tapped holes. Installation requirements are specified, together with details of the mountings. Inspection during construction is also stipulated, together with details of hydraulic tests. Price 2s., post free.

STEEL TUBES FOR CYCLE AND MOTOR-CYCLE PURPOSES

No. 1717 : 1951. This is one of a series of standards for steel tubes for general engineering purposes.

Three types of steel tube are covered : cold drawn seamless, electric resistance butt welded, and cold drawn electric resistance butt welded. Within each type a number of grades are specified. A general section lays down such requirements as the procedure for mechanical testing and dimensional tolerances, including straightness.

A table at the end of the standard gives a useful summary of the chemical compositions and mechanical properties of the complete range of tubes. Price 2s. 6d., post free.

Catalogues

EDGE AND SONS, Ltd., Wire Rope and Chain Works, Shifnal, Salop.—Booklet dealing with chains, wire ropes, forgings.

RICHARD SUTCLIFFE, Ltd., Universal Works, Horbury, Wakefield.—Set of pamphlets dealing with industrial conveying.

BASOL, Ltd., Basol House, Bolton Street, Piccadilly, London, W.1.—Booklet entitled "Facts About Degreasing."

PILKINGTON BROTHERS, Ltd., St. Helens, Lancashire.—Booklet entitled "Facts About 'Insulight' Double Glazing Units."

DAVID BROWN TOOL COMPANY, Park Works, Huddersfield.—Leaflet illustrating the application of gear-shaving cutters.

UNBRAKO SOCKET SCREW COMPANY, Ltd., Burnaby Road, Coventry.—Publication No. 3, "High-Tensile Socket Screws."

FUNDITOR, Ltd., Woodbridge House, 3, Woodbridge Street, London, E.C.1.—Leaflet describing drying and preheating ovens.

EVERSHED AND VIGNOLES, Ltd., Acton Lane Works, Chiswick, London, W.4.—Publication No. 242 of Evershed instruments.

BRITISH CENTRAL ELECTRICAL COMPANY, Ltd., 6 and 8, Rosebery Avenue, London, E.C.1.—Catalogue of electrical supplies.

CHURCHILL MACHINE TOOL COMPANY, Ltd., Broadheath, Manchester.—Booklet dealing with universal grinding machines.

RENOLD AND COVENTRY CHAIN COMPANY, Ltd., 28, Deansgate, Manchester, 3.—Leaflet giving applicational data and installation and erection instructions on the revised design of the Renold chain clutch.

ADAM MACHINE TOOL COMPANY, Ltd., Acme Works, Waverley Road, St. Albans.—Leaflets describing the Billeter universal engraving, drilling and contour milling machine, and the Dubied universal tool and cutter grinder machine.

NORDBERG MANUFACTURING COMPANY, Milwaukee 7, Wis., U.S.A.—Bulletin No. 183, describing type "4FS," one and two-cylinder, 4½in by 5½in diesel engines; bulletin No. 187, describing all types of machinery manufactured by the company.